DEDICATION ISSUE

NATIONAL BUREAU OF STANDARDS November 1966

Technical News Bulletin

U.S. DEPARTMENT OF COMMERCE

SPECIAL DEDICATION ISSUE

As this issue goes to press, plans are nearing completion for the dedication, on November 15, of the National Bureau of Standards' new laboratories at Gaithersburg, Md., just 20 miles northwest of the old site in Washington, D. C. In commemoration of this event, the issue has been devoted to articles on the new laboratory complex — its buildings, equipment, and facilities — designed to house the present and future research, development, and service activities of the National Bureau of Standards. In this modern installation the Bureau is better equipped than ever before to meet the Nation's measurement needs and to provide essential services to science and industry.

The official flag raising at the new NBS site, witnessed by A. V. Astin, Director, and I. C. Schoonover, Deputy Director, took place on the 65th anniversary of NBS, March 3, 1966. The base of the flag pole is inscribed with a remark made by George Washington to the Constitutional Convention, 1787.
"Let us raise a standard to which the wise and the honest can repair."

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

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U.S. DEPARTMENT OF COMMERCE
John T. Connor, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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COVER

Eleven stories high, the Administration Building at the National Bureau of Standards' new site near Gaithersburg, Md., towers above the other buildings in the laboratory complex. The building houses the Director and his staff as well as other NBS activities not requiring laboratory space.

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized into three institutes—
- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

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NBS OCCUPIES NEW FACILITY

Dedication and Special Symposium Planned

Visitors to NBS Gaithersburg during dedication week will become familiar with this emblem, designed especially for the occasion by Professor Ronald W. Sterkel, University of Illinois. The trio of interlocking arrows symbolizes the artist's conception of the dynamic nature of the Bureau's programs.

BY THE CLOSE OF 1966, transfer of the Bureau's Washington laboratories to a new ultra modern complex at Gaithersburg, Md., will be largely completed. Dedication of the $120 million facility at Gaithersburg has therefore been set for November 15, 1966. Secretary of Commerce John T. Connor will head the list of notables from government, science, and industry who will participate in the ceremonies. Distinguished visitors from both this country and abroad will be in attendance.

The invited guests will be given a tour of the new installation on the afternoon of the dedication. On Saturday, November 19, the NBS Gaithersburg laboratories will hold an open house for the general public. At that time about 100 laboratories and demonstrations will be on display.

In conjunction with the dedication, Secretary Connor is sponsoring a 2-day Symposium on Technology and World Trade, to be held November 16 and 17, on the NBS grounds. About 500 experts from all over the world are being invited by Secretary Connor to participate. They will meet to examine and forecast the impact of technology upon the patterns and conduct of international trade and investment, to consider the international environment needed for the wider generation and utilization of technology, and to explore prospects for evolving policies and institutions that promote economic development through technology and trade.

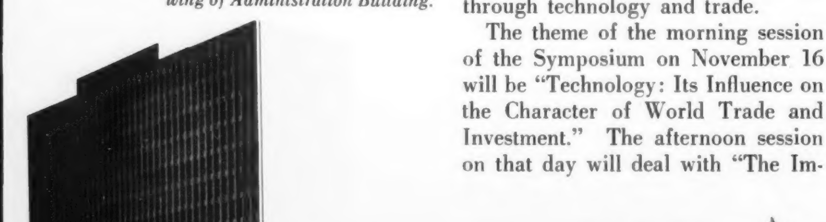
The theme of the morning session of the Symposium on November 16 will be "Technology: Its Influence on the Character of World Trade and Investment." The afternoon session on that day will deal with "The Impact of International Measurement Conventions, Norms, and Standards on World Trade." The themes for the two sessions on November 17 are: "Creating the Environment for Fruitful Interactions of Technology, Trade, and Economic Growth"; and "The Transfer of Technology Through Enterprise-to-Enterprise Arrangements."

The new Gaithersburg laboratories will enable the Bureau to plan and conduct a more effective program consistent with its increasing responsibilities. In recent years the explosive growth of science and technology has brought urgent demands for new and more accurate standards, better measurement methods, and greater availability of data on materials properties. Yet for some time the Bureau's research and service activities have been hampered by inadequate and outmoded laboratories at the old site.

The Gaithersburg move provides the Bureau staff with one of the most modern research installations in the country, its buildings designed for convenience for scientific work, flexibility in space arrangements, and adaptability to further expansion when necessary. (See The New NBS Laboratory Complex, p. 200 and General Purpose Laboratories, p. 206.) The 565-acre site contains adequate space for further construction, as well as for location of buildings that need to be relatively isolated, such as a reactor building. In addition, the rural location removes the Bureau's work from the variety of mechanical, electrical, and atmospheric disturbances present in a city and reduces the effects of these factors on precise scientific measurements. A further advantage of such a location is that scientific experiments can be conducted with a minimum of interference to community life.

In this environment, with laboratories equipped to take advantage of the latest advances in precision measurement, the Bureau is strengthening

Court in which dedication ceremonies for the Bureau's new laboratories will be held on November 15. Left: administration tower. Right: library wing of Administration Building.



its foundation to meet increased demands on the Nation's measurement capabilities in the years ahead. Among the new facilities at Gaithersburg are a high flux research reactor (see page 212) and a linear electron accelerator (page 220), 100 feet long, that produces one of the world's most intense electron beams. These two facilities will enable the Bureau to enter new areas of nuclear research, to obtain new information on the properties of materials, and to meet pressing needs for measurement and data services in such fields as nuclear physics, nuclear power generation, medical radiology, and the rapidly expanding use of radiation to process materials and products in industry.

In the new Engineering Mechanics Laboratory (page 215), a 12-million-pound capacity hydraulic testing machine and 7 highly accurate deadweight machines, with capacities up to 1 million pounds, have been installed for application of a broad range of forces to various types of specimens. Thus the Bureau is now much better equipped to study the mechanical properties of structures and to calibrate devices used to measure extremely large forces such as rocket thrusts and missile loads.

By January 1967, it is expected that all but about 300 of the Bureau's Washington staff of 2,700 will have been relocated at the Gaithersburg site in 15 major buildings. Most of those remaining at the Washington site will eventually be relocated in new special-purpose laboratories yet to be constructed at Gaithersburg (see page 224). In addition, the Bureau will continue to maintain a staff of about 600 in Boulder, Colo., for work in radio standards and cryogenics, and a staff of about 300 at the Clearinghouse for Federal Scientific and Technical Information at Springfield, Va., as well as small groups of employees at a number of widely scattered field stations.

Three Institutes To Be at Gaithersburg

The National Bureau of Standards provides measurement and technical information services essential to the efficiency and effectiveness of the work of the Nation's scientists and engineers. The Bureau serves also as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. To accomplish this mission, the Bureau is organized into three institutes which occupy the new Gaithersburg facilities.

- The Institute for Basic Standards provides the central basis within the United States for a complete and consistent system of physical measurement, coordinates that system with the measurement systems of other nations, and furnishes essential services, including measurement and dissemination of fundamental properties of matter, leading to accurate and uniform physical measurements throughout the Nation's scientific, industrial, and commerical communities. This Institute is located in the Engineering Mechanics, Metrology, Physics, Chemistry, Radiation Physics, and Administration buildings at the Gaithersburg site. It also maintains some activities at Boulder, Colo.
- The Institute for Materials Research assists and stimulates industry through research to improve understanding of the basic properties of materials, develops data on the bulk properties of materials, and devises measurement techniques for determining these properties. This Institute is located in the Metrology, Physics, Chemistry, Materials, and Polymer buildings at Gaithersburg. Its cryogenics division is at the Boulder laboratories.
- The Institute for Applied Technology develops criteria for the evaluation of the performance of technological products and services, provides specialized information services to meet the needs of the Nation's industrial community, and provides a variety of specialized technical services for other Federal agencies. This Institute is located in the Instrumentation, Building Research, and Administration buildings at Gaithersburg. It also operates the Clearinghouse for Federal Scientific and Technical Information at Springfield, Va.

DEDICATION
ISSUE / TNB

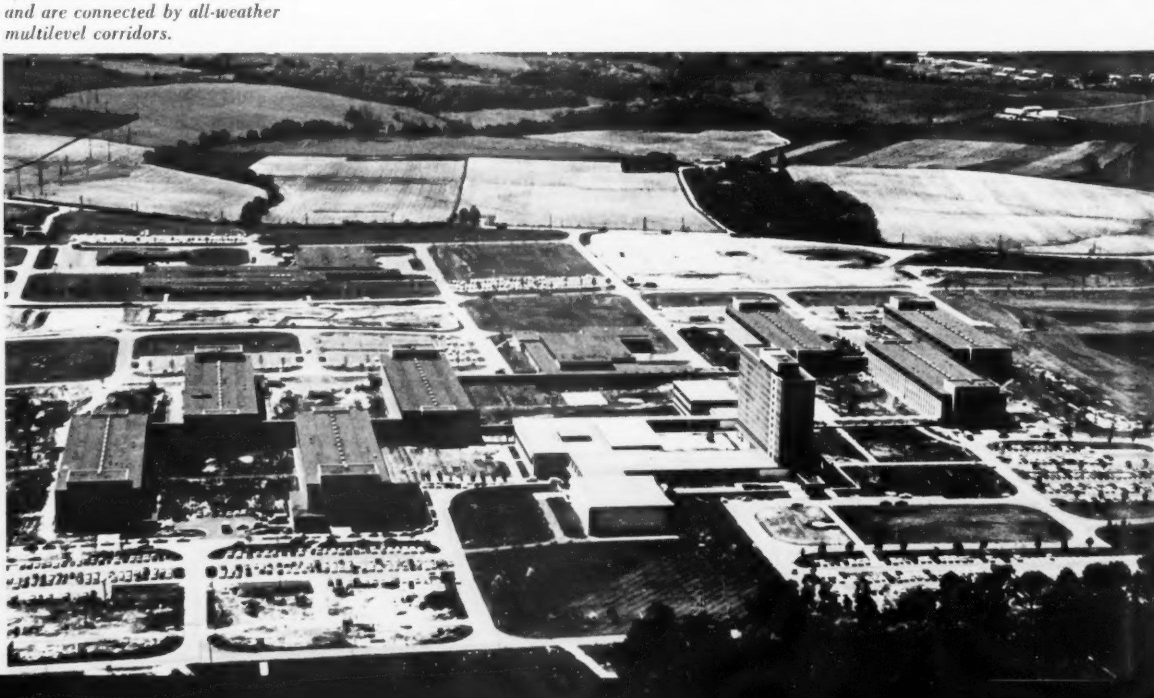
Former Secretary of Commerce Luther H. Hodges breaking the ground for the new NBS facilities, June 14, 1961. Participating were NBS Director A. V. Astin and John L. Moore, GSA Administrator.

Farm land purchased in 1956 for the new Bureau site near Gaithersburg, Md.

Designed for Present and Future Needs . . .

THE NEW NBS LABORATORY COMPLEX

The Administration Building, shops, and general purpose laboratories form the central core of the Bureau's laboratory complex and are connected by all-weather multilevel corridors.



The first major building to take shape at the new NBS facility was the Engineering Mechanics Building.

THE PLANNING AND construction of the Bureau's new $120 million complex at Gaithersburg was a monumental task involving the efforts of a large number of persons both in government and private industry. The objective was new quarters for one of the world's largest physical science laboratories, designed to meet the varied environmental and space requirements of many kinds of specialized equipment and delicate, highly precise measuring instruments.

Initial planning for the Gaithersburg complex began in 1955. At that time, after Bureau requests for funds to expand and modernize the Washington laboratories had been rejected, the Administration proposed that entirely new NBS facilities be constructed on a site outside of Washington. The opportunity presented by this proposal was so great that Bureau management decided to do its utmost to create facilities that would not only serve the Bureau for the present, but would be flexible enough to meet the needs of the rapidly changing fields of the physical sciences for many years to come.

New Facilities Long Overdue

The decision to relocate the Bureau was made by the Administration with the view to getting an important Government science facility outside a prime target area. Additionally, new facilities were obviously needed and were in fact long overdue. The premises in northwest Washington had become cramped and obsolete. Some of the buildings were over 50 years old in 1955, and totally outmoded as housing for modern scientific and technical equipment. Others, still being used, had never been intended as other than "temporaries," and still others were simply converted structures. Moreover, even if it had been economically feasible to renovate rather than build anew, the site would not permit any substantial expansion. There was no way to make room for the new nuclear reactor.

Limitations Imposed on Selection of Site

The Administration had placed two limitations upon the selection of the new site: it must be at least 20 miles from the center of Washington, and it could not be in the "Washington-Baltimore corridor."

Bureau management, in turn, imposed several other limitations on the selection of the new location: first, it must consist of at least 400 acres and must be relatively level and reasonably high; second, there should be good access by highway; and third, the site must be convenient to the homes of most NBS scientists.

Within these limitations, the General Services Administration screened more than 100 sites over a period of about 7 months. About 20 were submitted for consideration by the Bureau, which narrowed the number down to 8 for the final selection. The site on which the Bureau now stands was the first choice of GSA, and when the Director saw it, it was his first choice as well. It met all requirements admirably, and by coincidence was actually traversed by the 20-mile line from the center of Washington.

There were a number of reasons why the chosen plot of land had to contain a minimum of 400 acres. First was the need to provide a measure of isolation to all Bureau buildings from the sources of noise, vibration, and radiation that might arise as the areas surrounding the site are developed for residential or commercial purposes. Second was the need to provide isolation on the site for those Bureau activities which require separation from one another. Third was the need to provide land on the site for future facilities that might require large areas. The plot originally purchased contained 555 acres. Even so, it was necessary a few years later to acquire an additional 10 acres in order to provide the separation required by the Atomic Energy Commission between the nuclear reactor and the site boundary.

Appropriate Architects Sought

While the site was being selected, the choice of an architectural firm was also under way. Information was being assembled on those firms with the experience, competence, and the size necessary to accomplish the planning for a large research facility like the National Bureau of Standards.

The appropriation by the Congress for fiscal year 1957 became available July 1, 1956, for site acquisition and planning, and the site, which had been viewed by the Director for the first time only a few weeks earlier, was taken in July of 1956. The architectural firm of Smith, Haines, Lundberg & Waehler (formerly Voorhees Walker Smith Smith & Haines) was selected shortly thereafter for the preliminary planning. This firm had designed and built some 10 million

continued

NEW COMPLEX *continued*

square feet of research laboratory space since World War II, including laboratories for many of the larger industrial firms, such as Dupont, General Electric, Ford, IBM, and Bell Telephone Laboratories.

It was the desire of the Bureau, of the General Services Administration, and of the architects to gain as much as possible from the experience of others who had designed and built laboratories in recent years. To this end Bureau staff members, accompanied by representatives from Smith, Haines, Lundberg & Waehler made visits to many of the newer laboratories to gain information from the successes and failures of others. Data were obtained on construction materials used, dimensions of laboratory and office modules, methods for distributing laboratory services, kinds of services distributed, criteria used for assigning space, and many other items of interest. While these studies were being made, the architects also had teams at work at NBS assembling information from all divisions and sections as to their precise needs.

Staff Recommendations Invited

Because of the expressed needs and desires of the staff over the years, the Director wished to involve the employees as much as was reasonable in the planning of the new facilities. He established a Laboratories Planning Committee comprised of Bureau scientists including several outstanding younger scientists. The name of this committee was probably a misnomer because it was not intended that they design the laboratories; it was their purpose to establish some of the more important criteria upon which the plans were to be based.

The recommendations of this committee were made available to the architects and virtually all were incorporated in the planning. The committee has remained in existence to consider special problems on which management has needed advice. In addition, the Director named an interference "czar" whose job it was to investigate and resolve questions arising during the planning relating to interference caused by laboratory sources of noise, vibration, or radiation. Combating interference and working toward compatibility were not restricted to the planning stage, of course; these activities require a continuing effort at NBS.

The concept of a general plan for the Gaithersburg facilities did not evolve in a simple, straightforward fashion. There was backtracking and reconsideration of ideas once considered and once discarded.

First Plan: A Monolithic Structure

The first estimates of cost had been made by the General Services Administration in support of the first NBS request for funds. This estimate refered to "a monolithic block-type structure" of a little more than 1 million assignable square feet to accommodate a projected staff of 3,000.

After the architects had been engaged and had worked for months with most of the supervisors and staff of NBS to ascertain their needs, the architects concluded that the Bureau's requirements could not be accommodated in a single structure. Their alternate suggestion was to build three principal laboratory facilities plus a complex of administration and service buildings. These three laboratory facilities were to be a physics laboratory, a chemistry laboratory, and an engineering laboratory. Even this effort to place the laboratory facilities of the Bureau in three buildings resulted in the buildings having strange shapes to accommodate some of the unique scientific equipment that would have had to go into them.

When a subsequent appropriation was received for the detailed planning of the new facilities the Budget Bureau requested NBS to have the architects make another effort to place all of the facilities in a single structure. The architects, working with the Bureau and the Public Buildings Service, spent several months making studies of configurations that could bring together most, if not all, of the Bureau facilities. A number of interesting designs developed. Had one of these been accepted, the Bureau at Gaithersburg might have become known, for instance, as the Hexagon. However, the architects' studies developed the fact that some of the Bureau's activities were incompatible with others and could not reasonably be integrated, and also that a single building for NBS would not be as economical to

Entrance to the large auditorium (left) where many conferences and symposia are held. This auditorium is connected by enclosed walkways (part of which are seen here) to the main portion of the Administration Building at the National Bureau of Standards' facility at Gaithersburg, Md.

construct as would several buildings. The architects therefore concluded that detailed planning should be on the basis of a multistructure design. GSA, NBS, and the Budget Bureau considered the architects' study and accepted their recommendation.

In substance, this recommendation advised placing all the office and laboratory operations that were reasonably compatible into a single central structure, and segregating in separate buildings those operations that required isolation for any of a number of reasons. Of this latter, there were 13: Radiation Physics Laboratory, which would contain the Bureau's sources of radiation produced by particle accelerators, Nuclear Reactor, Engineering Mechanics Laboratory, and Steam and Chilled Water Generation Plant, these four buildings at this writing being completed and in use; four buildings which are presently under construction—Hazards Laboratory (where experiments having a relatively high probability of accidents would be performed); Industrial Building, Sound Laboratory, and Concreting Materials Building; Fluid Mechanics Laboratory and Non-Magnetic Laboratory, presently in the planning stage; and two laboratories which have been indefinitely postponed—Fire Research Facility and High Voltage Laboratory.

It had not originally been planned to move the High Voltage and Fluid Mechanics work from Washington to Gaithersburg, but NRC advisory committees had pointed out unfulfilled needs, and the laboratory was subsequently put back in the planning.

As an economy measure, the decision was eventually made to place the supply and plant divisions in a separate low-cost, one-story, warehouse-type structure and the garage in a small one-story structure.

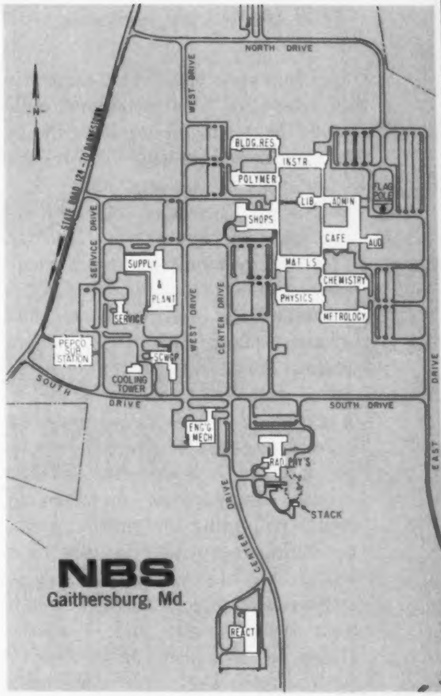
This still left most of the scientific work of the Bureau, the Director's offices, most of the administrative divisions, and the shops division to be placed in a single building. The architects labored over various schemes and finally concluded that a single building to accommodate all of these people and activities would be exceedingly big and cumbersome and would not lend itself well to future expansion. They then evolved a scheme of a central administration building housing the Director's office, most of the administrative support employees, the meeting facilities, and the library, this building to be surrounded by a number of "general purpose laboratories" and a shops building. As this plan developed, the architects incorporated virtually all of the recommendations of the Laboratory Planning Committee.

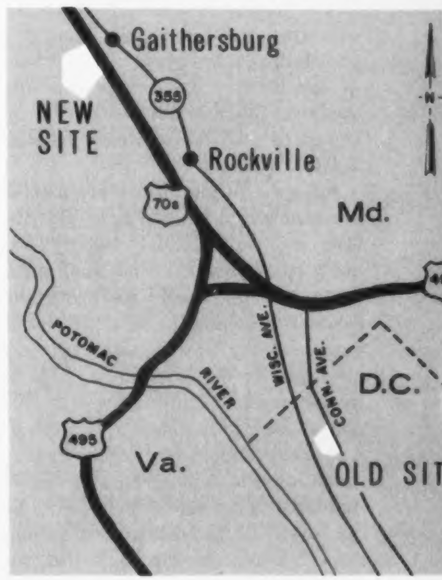
General Purpose Laboratories Evolve

The general purpose laboratory buildings took size and shape; their uniform dimensions finally becoming 105 feet in width and 385 feet in length. Four of the seven are three stories in height, but the other three required basements for functional reasons, as well as three stories above ground. To maintain the concept of a single structure, the general purpose laboratories were joined together by full-height corridors. Thus, an organizational entity within the Bureau can be grouped together not only by stacking the component groups one floor above the other within a building, but by placing them side by side on the same floor in adjoining buildings since the corridors connecting the buildings are only 50 ft. long.

These buildings are called "general purpose laboratories" because the space is intended to be suitable for most of the work performed within NBS laboratories. Within these buildings changes from one laboratory purpose to another can be made with relative ease. They are described in a separate article on page 206.

The Administration Building was designed to provide offices for the Director and his staff, the administrative support staff, and the library, and to provide meeting and dining facilities





The new NBS site is 20 miles northwest of the old Washington site, at the Darnestown exit of Interstate Highway 70S. It borders and is west of 70S and Gaithersburg, Md. The plan view shows the layout of existing buildings (see also back cover).

NEW COMPLEX *continued*

CONSTRUCTION TABLE—GAITHERSBURG FACILITY [1]

Major Components		Prime Contractor	Schedule: *Contract let*	*Completion*
SITE ACQUISITION (565 acres)		....		July 1956
DESIGN & ENGINEERING		Smith, Haines Lundberg & Waehler	Dec. 1956	....
CONSTRUCTION				
Phase 1:	Engineering mechanics laboratory, powerplant, initial site work.	Paul Tishman Co., Inc.	June 1961	Aug. 1963
Phase 2:	Radiation physics laboratory, administration and service bldgs.	Blake Construction Co., Inc.	June 1962	Aug. 1965
Phase 3:	Seven general purpose laboratories.	J. W. Bateson Co., Inc.	Aug. 1963	Sept. 1966
Phase 4:	Special purpose laboratories (sound, hazards, industrial, concreting materials).	J. W. Bateson Co., Inc.	Apr. 1966	Apr. 1968
Phase 5:	Fluid mechanics, nonmagnetic laboratory and gatehouse.		In planning stage	
Reactor		Blount Brothers Corp.	Apr. 1963	Sept. 1966

[1] Robert S. Walleigh, NBS associate director for Administration, was in general charge of the Gaithersburg construction and relocation project. In addition, Hylton Graham, chief of the NBS plant division, was reassigned to head a Gaithersburg planning staff of 8 persons.

for the entire site. The office wing, or tower as it is sometimes called, could be made higher than the laboratory buildings with some resultant economies in construction, and this height also provided an interesting architectural feature for the site. The meeting facilities are designed to accommodate scientific meetings of moderate size. There is an auditorium seating 800, a smaller one seating 300, 3 lecture rooms seating 100, 1 each for 50 and 25 people, and 2 seating 12. This area permits concurrent meetings of varying sizes, as, for instance, a symposium in which several simultaneous meetings are held. Adjoining the meeting area is the dining area which includes a staff lounge, useful for coffee periods for visitors attending meetings; a cafeteria seating 650; and 3 smaller dining rooms which can be reserved for luncheons by groups of scientists.

The library is a section of the Administration Building consisting of a two-story-plus-basement wing back of the tower. At present it accommodates 126,000 volumes and is designed to provide expansion to some 200,000 volumes.

Adjacent to the library are a small museum and a standards vault. Before the Gaithersburg facility was built, the Bureau had not had space for a museum; here are being collected the memorabilia of 65 years' service as the Government's primary physical sciences research facility. In the vault, behind glass, are displayed the Nation's standards of physical measurement, or—where space limitations do not permit the entire standard—a symbolic part, such as the "oven" of the cesium beam atomic clock. Here, for example, is the prototype kilogram.

From the museum, a graceful glassed-in walkway leads from the first floor of the tower to the dining and meeting areas. One can leave the walkway and step out into the central court, a pleasant open area with small fountain and pool, a large weeping beech tree, and other landscaping.

The meeting, dining, and library facilities were intended to provide greater flexibility in present and future plans for scientific meetings, educational programs, and for the day-to-day meeting and dining needs of the staff. These needs have been met with designs which are proving to be both useful and attractive.

Group Functions as a Unit

The fully enclosed corridors interconnecting the seven general purpose laboratory buildings, the Shops Building, and the Administration Building are intended to make this group of buildings operate as a single building. However, each of the buildings has its own separate area for staff and visitor parking. A system of roads and streets has been established providing access to buildings and parking areas, and connecting with strategic exits to surrounding state and county roads.

All mechanical and electrical utilities are furnished to the Gaithersburg complex via underground conduit and pipe systems. Electric power to all buildings is fed from a site substation owned and maintained by the Potomac Electric Power Co.

Two 69/13.8 kV transformers feed Government-owned primary switchgear of the 15 kV class. The switchgear consists of three sections interconnected with tie breakers and a transformer bus to form a network. Power is distributed on the site at 13.8 kV by three 3-phase feeder cables which energize a 3-element spot network in each major building.

Fire alarm and other supervisory systems from each building are connected to central panels in the Administration Building and the Steam and Chilled Water Generation Plant.

Steam for heating and laboratory uses and chilled water for air conditioning and heat exchanging purposes are distributed from a central location.

A. G. McNish, Chief of the Metrology Division, places the prototype kilogram standard in the Standards vault (adjacent to the museum and library) during the recent transfer of standards from the old site to Gaithersburg.

Steam is provided by four 4,500-pounds-per-hour boilers. Chilled water is generated by four 3,000-horsepower centrifugal refrigeration compressors. This is one of the largest single unit refrigeration installations of its type in the country.

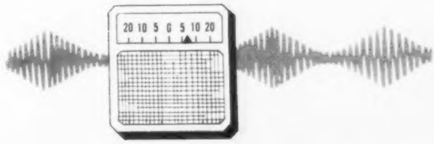
Other available utilities include water, burner gas, compressed air, vacuum, and sanitary and laboratory waste disposal.

The site has been planned with a view to the future. Areas have been set aside for future expansion for all buildings except the general purpose laboratories. Here, expansion is to be accomplished by the addition of one new laboratory at a time, as needed. Provision has been made for seven additional general purpose laboratories with parking areas.

A minimum amount of sidewalk has been provided between the central complex of buildings only, with additional sidewalks planned for the future as needs develop.

NBS has long been known for the beauty of its grounds, and this feature has not been neglected at Gaithersburg. A detailed basic planting plan was evolved, and more than 3,000 trees and shrubs have already been planted. Two carefully preserved original wood plots are being developed into special attractions: one as a glade, with light shade, grass, and picnic benches; the other as an open, flowering woods with winding paths and azaleas, which are being planted in the sunny areas.

As the various laboratories settle into their new quarters, minor changes and modifications will naturally be called for. However, "operating successfully—fulfilling its function" are the words which best describe this impressive complex of buildings, housing one of the world's largest collections of equipment—massive, delicate, esoteric—for measurement and research in the physical sciences. As such, it stands as a credit to everyone who participated in the arduous and sometimes frustrating job of planning and building.



STANDARDS AND CALIBRATION

STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz.
WWVH—2.5, 5.0, 10.0, and 15.0 MHz.
WWVB—60kHz.

Radio stations WWV (Fort Collins, Colo.*) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. Adjustments are made at 0000 UT (7 p.m., e.s.t.) on the first day of a month. There will be no adjustment made on 1 December 1966. The pulses occur at intervals that are longer than 1 second by 300 parts in 10^{10} due to an offset in carrier frequency coordinated by the Bureau International de l'Heure, Paris, France.

Radio station WWVB (Fort Collins, Colo.), broadcasts seconds pulses derived from the NBS Time Standard with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. NBS directs that such adjustments be made in the scale at intervals to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on 1 December 1966. The seconds pulses emitted from WWVB will be retarded 200 ms.*

* At midnight UT, 30 November 1966, all transmissions from WWV, Greenbelt, Md., will cease and at 0000 UT, 1 December 1966, WWV, Fort Collins, Colo., will start broadcasting. For further details, see **Starting date of relocated WWV**, NBS Tech. News Bull. **50**, No. 10, 184 (October 1966).

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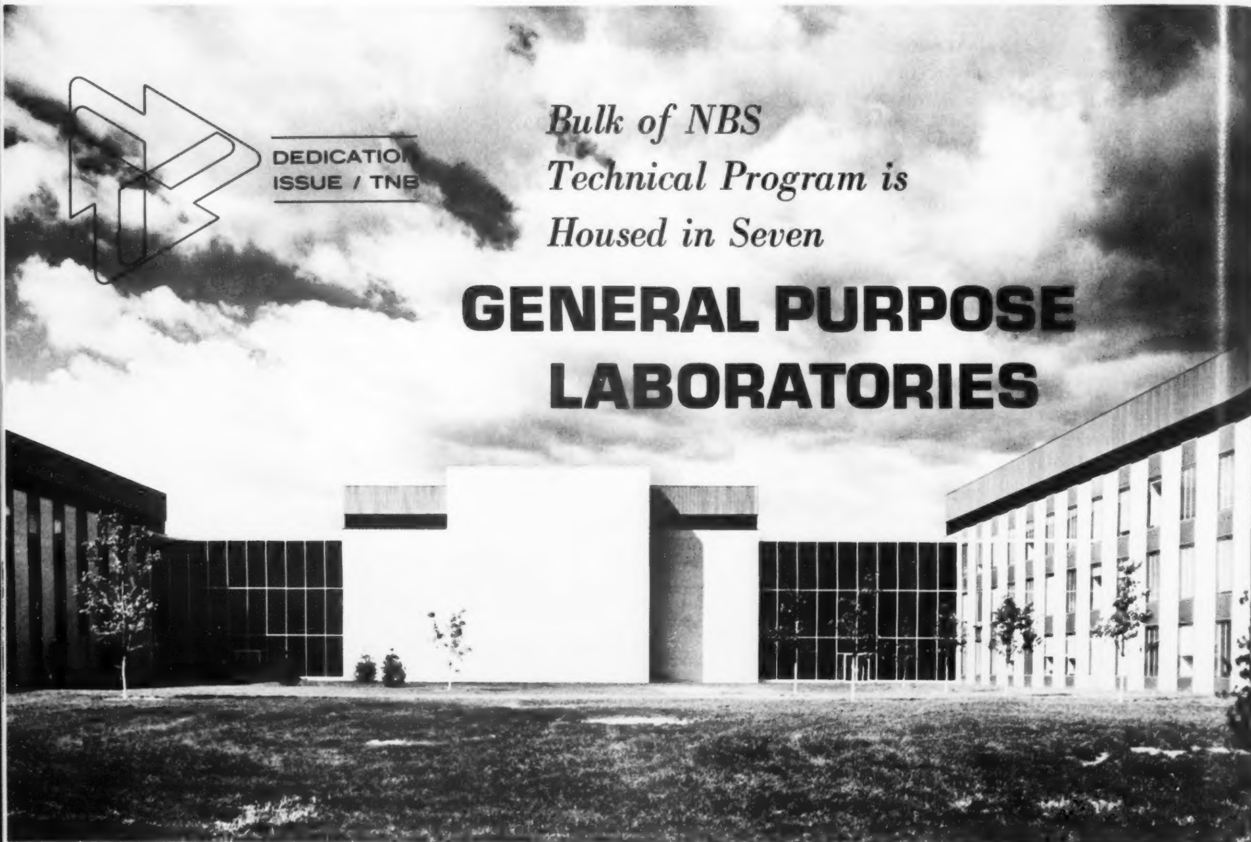
Bulk of NBS Technical Program is Housed in Seven GENERAL PURPOSE LABORATORIES



The 50-ft-long, three-level corridors permit organization entities to be grouped together side by side on the same floor in adjoining buildings as well as being stacked in the same building.

CLOSE TO 70 PERCENT of the total space for technical program use at the new NBS Gaithersburg site is within the walls of seven General Purpose Laboratory (GPL) buildings. These modern structures were erected and equipped at a cost $38,000,000, and will accommodate, to start with, about 1,500 scientists and engineers and their staffs who were formerly distributed among 48 buildings at the Washington site.

The GPL's are arranged around a central core of administration and common use areas: the Administration Building, Library, Auditorium, Cafeteria, and Shops. Radiating out from this core are all-weather passageways that lead to four GPL's to the south, Metrology, Physics, Chemistry, and Materials; and to three GPL's to the north, Polymer, Instrumentation, and Building Research. Parking areas scattered nearby give convenient access to all working areas.

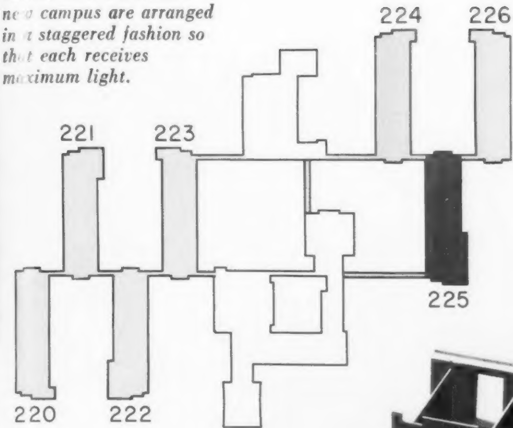
Modular Space Units

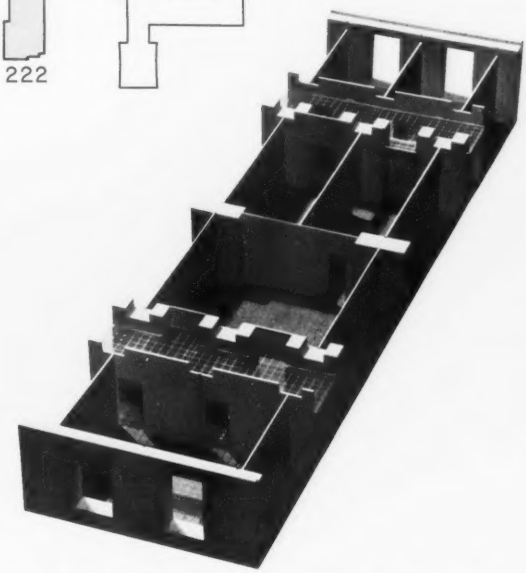
A GPL, by definition, is adaptable to most scientific purposes and may be converted from one use to another, say from chemistry to electronics, with relative ease.

The key architectural concept for achieving this adaptability and flexibility is the "modular space unit" or "module" for short. A module is the smallest repetitive unit of space that is completely equipped with laboratory and building services. It may be used as an individual work area or combined with other units to create work areas of various sizes that can be modified in step with changes in program requirements.

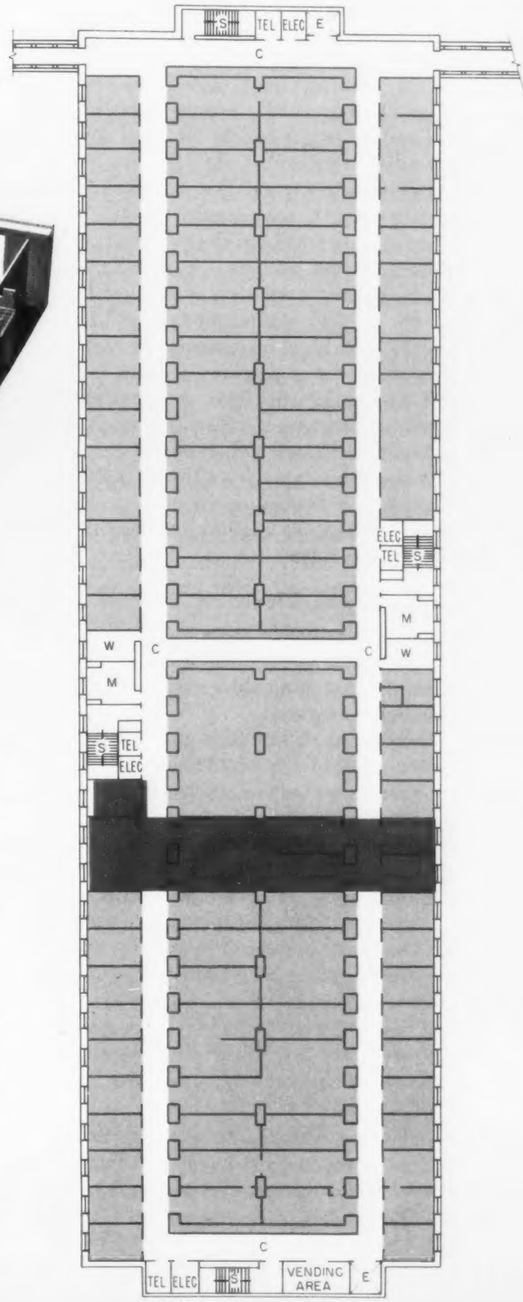
The basic laboratory module is 11 by 24 feet. Another, smaller module, 11 by 16 feet, is intended primarily for office occupancy, although it can with certain limitations be used for laboratory work.

The interconnected laboratories (shaded below) at the Bureau's new campus are arranged in a staggered fashion so that each receives maximum light.





Layout of a typical floor of a general purpose laboratory. Drawing shows tentative subdivision of the 2nd floor of the Instrumentation Laboratory (darkest building top left) into offices and laboratories. The layout below shows (shaded) the offices on the outside and the labs on the inside of the corridors (white). A cross section (dark grey) and a close up (left center) have the internal partitions left out of the rooms in the foreground to form double-size office and work areas.



Additional flexibility of space arrangement is given by movable metal partitions which allow the working areas to be set at any multiple of the 11-foot dimension. Also, the center spine partition that normally divides two back-to-back laboratories, can be omitted. This would provide a room 48 feet deep to accommodate equipment of unusual length.

Overall Construction, Noise Reduction

Four of the GPL's have three stories and an attic; the other three have, in addition, a full basement. The south half of the Building Research Laboratory (building 226) is divided lengthwise into high-bay spaces two and three stories high. The northern half has the standard three-story structure.

Construction is of reinforced concrete faced with brick. The high bay portion of the Building Research Labora-

continued

GENERAL PURPOSE LABORATORIES
continued

tory has a steel frame construction, with girt-supported metal panel exterior walls.

Each building is 105 by 385 feet, with Laboratory modules back-to-back at the longitudinal centerline and separated from the perimeter office areas on each side by a 6-foot wide corridor. There are 60 large laboratory modules on every floor and an average of 56 offices, or limited laboratory units. Cross corridors at each end and at the center of every floor provide access to rest rooms, stairways, elevators, and concourses between buildings. A combined passenger-freight elevator, serving all floors plus the attic, is located at the lobby or receiving end of the building; while a smaller passenger elevator at the other end serves only the occupied floors.

All mechanical and electrical utility equipment is housed in the attic. From there, utilities are distributed overhead along the long (east-west) axis of the building and then downfed via vertical shafts, modularly located at 11-foot spacing, to individual laboratories as required.

A considerable effort was made to prevent noise and vibration of attic equipment from being transmitted through the building structure. Rotating machinery is mounted on vibration isolators and placed on specially designed concrete bases insulated from the attic floor slab. This basic precaution is backed up by acoustic lining in ductwork, flexible connections at all branch ductwork, and acoustic lining of fan casings.

Mechanical and Electrical Utilities

Mechanical services available at each modular line include steam, compressed air, chilled water for heat exchanging, burner gas, hot and cold water, distilled water, and special gases when required.

Laboratory waste is carried in glass pipe on all runouts and verticals, connecting to a cast-iron house sewer. From there it goes to a treatment station before entering the site sanitary sewage system.

The electrical distribution system consists of three 13,200/480/277-volt network transformers, located in a penthouse, which feed the lighting and 480-volt power systems; and two 480/120/208-volt transformers located at the center of the building on the attic level. The two latter transformers supply all 120/208-volt service and feed individual cables to alternate vertical shafts serving laboratory areas on the floors below. Thus the transformers which provide power for laboratory usage are isolated from those which provide power for lighting and for building mechanical services.

Two sets of underfloor ducts carry electric, telephone, and signal services to the perimeter office modules. Special electrical services for the laboratories, such as standard frequencies, direct current from batteries or rectifiers,

One of the all-weather corridors that connect the general purpose laboratories to each other.

and interlaboratory plugboard systems, are fed through alternate service shafts.

General lighting is by fluorescent fixtures operated at 277 volts. Incandescent lighting at 120 volts is provided in special cases.

Stills for distilled water, 400-cycle generators, brine systems for low-temperature work, rectifiers, emergency generators, and other special-purpose equipment to serve a particular laboratory will normally be located in the attic as needed.

Heating and Air Conditioning

Two basic systems are used for space temperature control, one for the outer (office) rooms and one for the interior laboratories.

Take the outer rooms first. In hot weather, air from the outside is taken into the attic where it is refrigerated, with the help of chilled water from a central plant (building 302) on the site, to a temperature close to 50° F. This air is distributed to the offices on a zone basis, with four casings or zone systems for the perimeter area in each building.

To enter the offices, the air must pass through a "low pressure induction unit" below each of the windows in the room. In these units the air flows over hot water pipes and, by controlling this flow, the final temperature can be adjusted to meet individual needs.

In winter, the process is the same, except that the air from outside is heated, using steam piped in from building 302. The air reaching the induction units below the windows again needs a little further heating by passage over hot water pipes. The same temperature control serves for both summer and winter.

The heating and cooling system for the interior lab-

oratories differs from the preceding primarily in that each laboratory, or 11-foot module, has its own supply duct from the attic. Also, the hot water "reheat" units are in the attic, though they are controlled by a thermostat in each laboratory.

Air from the perimeter rooms is returned to the zone supply casing via the corridor and pickup ducts. Part of this air can infiltrate the laboratory areas for fume hood makeup. Air supplied to the interior laboratories may either be returned to the supply casing via ducts or exhausted directly to the outside if fume hood is installed.

As each 11-foot interior module has its own separate exhaust duct and a separate air supply, there is considerable flexibility in controlling the atmosphere in any particular space. This has the further advantage of reducing the chance of cross contamination in critical areas.

In addition to the normal temperature and humidity controls and filtration provided by the system supply casing, the environment in each room can be further modified by installation of booster cooling coils, moisture eliminators, humidifiers, or high-efficiency filters.

Special Areas

There were a number of cases where the laboratory requirements were so highly specialized that adaptability and flexibility had to be largely sacrificed. Some of the areas in this category are described briefly in what follows.

Tape Calibration Facility. This is a room 320 feet long, 11 feet wide, and 8 feet high in the basement of the Metrology Laboratory. It was built underground to achieve a more constant and uniform distribution of temperature. Further temperature stability is provided by its double-shell, cavity-wall construction, the cavities being stuffed with insulating material. Refrigerator-type doors are located at each end of the tunnel and also 60 feet from the west end. These can divide the "tunnel" into two sections, so that, in effect, there are three calibration areas: the long, undivided 320-foot tunnel itself; an intermediate 260-foot section; and a short 60-foot section. The two sections made by closing the refrigerator doors are served by separate, independently controllable brine systems which can hold the temperature constant within 0.5°F in the range from 50 to 100°F. An isolated floor slab and specially designed concrete piers reduce transmission of building vibrations to tape calibration equipment.

Photometric Range. This is another long (320 x 12 x 10 feet) underground tunnel, adjacent to the Tape Calibration Facility. Seven light-tight baffles, spaced at equal intervals, divide the tunnel into eight compartments, each served by a photometric control panel remotely controlled from a central console. Mounted on the south wall, but separate from the optical range proper, is a "tunnel within a tunnel," a 3-foot-square light-tight optical shaft that runs the full 320-foot length of the room.

Spectroscopy Area. In the basement of the Physics Laboratory, structurally isolated from the main building to minimize transmission of vibrations, is an area approximately 80 by 120 feet. This area is subdivided into a number of smaller rooms which will house a variety of types of spectrographs, including a 40-foot Rowland Circle. A floor trench system distributes power and control cables, together with all required mechanical utilities, to these instruments. A special feature of this complex is a light shaft leading to a coelostat on the roof. The latter is a mirror system that constantly (clouds permitting) reflects the sun's rays down the shaft to one of the spectrographs where high-resolution intensity measurements can be made at selected wavelengths.

Building Research Special Areas. As mentioned, the south half of the Building Research Laboratory consists of a group of specially designed multistory spaces. These will be devoted to development and testing of air conditioning, refrigeration, and heating equipment, and to testing of large-scale structural members, full-size wall panels, and other units of building materials.

The floor of one of these areas, the Environmental Engineering Laboratory, has been left in its original state of undisturbed earth. A full-size "house" will be built within this laboratory for testing heating and air conditioning equipment while the model is subjected to a variety of artificially created climatic conditions. Studies of heat losses through walls, roofs, and foundations can thus be obtained under conditions matching those "anywhere on earth" without leaving the confines of the laboratory.

Another of these areas, the Structural Test Laboratory, has a concrete tiedown mat 6 feet thick. High-tensile-strength bolts embedded in the mat will be used to apply stress to reinforced concrete or composite structural members as large as 90 feet in length.

One of the 11 by 24 feet laboratory modules in the general purpose laboratories. Here, scientists are using radioisotopes to detect very small quantities of a variety of elements in standard reference materials.

NATIONAL STANDARD REFERENCE DATA SYSTEM — NSRDS NEWS

This column regularly reports significant developments in the program of the National Standard Reference Data System. The NSRDS was established in 1963 by the President's Office of Science and Technology to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the National Bureau of Standards through the NBS Office of Standard Reference Data, located in the Administration Building at the NBS Gaithersburg Laboratories.

JILA Information Center

THE INFORMATION CENTER of the Joint Institute for Laboratory Astrophysics, located on the campus of the University of Colorado, is headed by Lee J. Kieffer of the NBS staff. The center is partially supported by both the Advanced Research Projects Agency (ARPA), through the university, and NBS through the National Standard Reference Data Program.

As part of the NSRDS, the JILA information center collects and critically evaluates low-energy electron collison cross sections, photoionization and absorption cross sections, and electron transport data. The collection of such data is a continuous process of searching the literature and periodically updating the bibliography. The collection phase has now become stabilized and the center's emphasis has shifted to the compilation and critical evaluation of data.

Several papers in this second phase are completed or nearly so. The first is a critical review by L. J. Kieffer and Gordon H. Dunn entitled "Electron Impact Ionization Cross-Section Data for Atoms, Atomic Ions, and Diatomic Molecules: I. Experimental Data," published in the *Reviews of Modern Physics*, vol. 38, 1–35, 1966. Part II, "Theory and Comparison with Experimental Data," is being written by M. R. H. Rudge, L. J. Kieffer, and Gordon H. Dunn. Two other critical reviews in progress are: "Electron Impact Excitation of Atoms (Experimental and Theoretical)," by S. J. Smith and B. L. Moiseiwitsch; and "Total Scattering and Elastic Scattering (Experimental)," by B. Bederson and L. J. Kieffer. In addition, work has recently begun on the compilation of the photoionization and electron transport data bibliographies.

The reports of the information center are available as publications in recognized professional journals; as publications in the NSRDS series for sale by the Superintendent of Documents, U.S. Government Printing Office; or as JILA Information Center Reports. Updated bibliographies are distributed to approximately 500 persons on the JILA information center mailing list, along with notification of other publications. The Center does not do literature surveys but will send its latest bibliographic data on request.

Bibliography of Flame Spectroscopy Published

Normally the product of the National Standard Reference Data System consists of a bibliography and a data compilation for a field. Sometimes only the bibliographic portion is supplied, as when the source literature has been identified but the data compilation has not yet been undertaken. The bibliography may be so widely useful that its publication alone is justified. This is particularly true when data are being produced so rapidly that an up-to-date compilation must wait until a plateau in data production is reached.

An example is, *Bibliography of Flame Spectroscopy (Analytical Applications) 1800 to 1966*, by Radu Mavrodineanu. Flame spectroscopy, with the closely allied field of atomic absorption spectroscopy, is a subject of major current interest. When the Office of Standard Reference Data considered ways to provide assistance in this area, a new compilation did not seem advisable. Several useful tables of atomic wavelengths were already in existence, and if they were to be revised, the data from methods other than flame spectroscopy should be added. However, the literature on flame spectroscopy was growing so rapidly it was overwhelming analytical chemists in the field.

Fortunately, the Office of Standard Reference Data was able to obtain the assistance of Dr. Mavrodineanu's employer, the Philips Laboratories (a division of North American Philips Co., Inc.), to help support the work which took much of Dr. Mavrodineanu's time for a full year. The result is a book of 250 pages containing 5,113 references, indexed in depth according to a scheme which takes account of the needs of research scientists, analytical chemists, and technicians. *Bibliography of Flame Spectroscopy (Analytical Applications) 1800 to 1966* will be

available as NBS Miscellaneous Publication No. 281, and will be sold by the Superintendent of Documents, U.S. Government Printing Office.

Thermodynamic and Transport Properties

Recently arrangements have been made for NBS projects on low temperature heat capacities and on diffusion coefficients in metals to obtain bibliographic information from the Thermophysical Properties Research Center at Purdue instead of doing their own literature search. This is stimulating further consideration of sharing literature searching in other areas of thermodynamics.

A small program for the compilation of vapor-liquid equilibria from multicomponent systems at high pressures has been initiated with Bruce Sage at the California Institute of Technology. Loren Hepler at the Carnegie Institute has assumed responsibility for compiling electrochemical data on non-aqueous solutions and George Janz of Rensselaer Polytechnic Institute has undertaken a compilation of similar data in fused salt systems. These latter two programs are being coordinated with Walter Hamer's program at NBS for compilation of electrochemical data in aqueous systems.

Plans for Information Handling in the NSRDS

NBS Technical Note 290, Information Handling in the National Standard Reference Data System,[1] by Franz L. Alt, presents a preliminary plan for the selection, acquisition, intellectual organization, and storage of NSRDS information, and for locating, retrieving, and displaying or communicating specific items of information when needed. This publication discusses the use of computers for these purposes, including selection of equipment, arrangement of digital storage input format, remote access, and the economies of choosing certain functions of the system for mechanization. Also, an interim system, based on conventional and manually operated files, is described.

Dr. E. U. Condon of the University of Colorado (left, seated) confers with (from left to right) Drs. S. J. Smith, NBS–JILA; B. L. Moiseiwitsh, Queen's University of Belfast, Ireland; and L. J. Kieffer, NBS–JILA about the forthcoming critical review on electron impact excitation of atoms.

Technical Note 290 discusses other important problems in systems planning which are being studied in the Office of Standard Reference Data. These include: the storage of pictorial information on a computer and the possibility of transmitting such information over long distances; problems of indexing and classifying data on physical properties; communication between data centers and the Office of Standard Reference Data, and between centers and users (especially for work sharing of literature scanning by associated centers), the development of software programs for computer-controlled typesetting (NSRDS News, TNB, p. 140, August 1966); and a project for a bibliographic survey of existing data compilations (NSRDS News, TNB, p. 98, June 1966).

[1] NBS Tech. Note 290 may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or from the Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce, Springfield, Va. 22151, for 25 cents.

WWV TO SEND FIRST DAY QSL CARDS

Transmissions from the new facilities of NBS radio station WWV at Ft. Collins, Colo., beginning December 1, 1966, will be welcomed not only by scientists and communications engineers, but also by amateur radio operators. These "ham" operators have relied for years on WWV transmissions as an ultrareliable frequency source in calibrating receivers and in keeping transmissions within band limits. Station WWV also responds to requests from ham operators and shortwave listeners by sending "QSL cards"—used for verifying radio contacts and for obtaining technical information on station equipment.

To mark the start of operations from its new site and to survey its listeners, WWV will respond with FIRST DAY QSL CARDS to operators and shortwave listeners reporting reception during its first day at the new site. The special QSL card carries a picture of the new station and its eight antennas at Ft. Collins. It will be sent in response to reports of reception correctly quoting a WWV voice announcement during the first day of operation, beginning 0000 UT December 1, 1966 (7 p.m., e.s.t., November 30). The reports should be sent to David H. Andrews, Frequency-Time Broadcast Services Section, National Bureau of Standards, Boulder, Colo. 80302 and be postmarked before midnight December 2, 1966, local time.

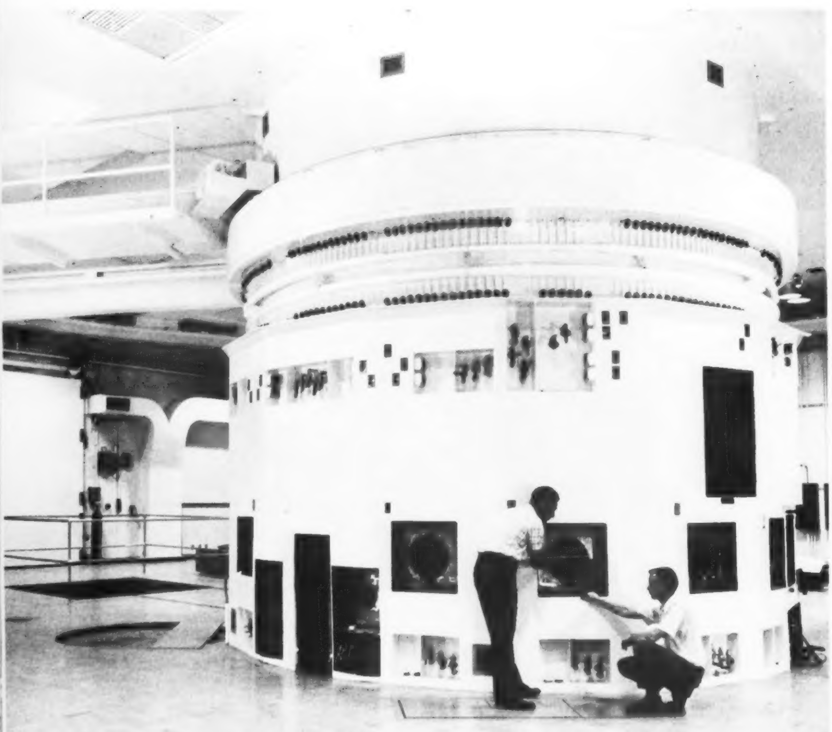
DEDICATION
ISSUE / TNB

NBS Completes High-Flux REACTOR

CONSTRUCTION OF THE National Bureau of Standards Reactor is now complete at the Bureau's new site at Gaithersburg, Md. Soon to become operational, this 10-megawatt reactor will provide NBS and other scientific laboratories in the Washington area with an extensive central facility where neutron beams can be used for fundamental research on materials of all kinds.

Because neutrons are deflected only by collisions with other particles and not by electric charge, they have wide experimental application in studies of the nature and properties of matter. "Fast" (up to 10 MeV) neutrons are used to study nuclear reactions. Crystallographic arrangements of atoms are explored by "slow" (about 0.025 eV), or "thermal," neutrons.[1] "Cold" neutrons (having energies on the order of 0.001 eV) are uniquely suited to the study of the dynamics of molecular systems.

The intense thermal neutron beams provided by the reactor will constitute a powerful tool in the analysis of the structure of solids and liquids by neutron diffraction. This technique can be applied to investigate various aspects of crystal structure, such as the location of hydrogen atoms, magnetic crystal properties, intermolecular force constants, and chemical bond strength.



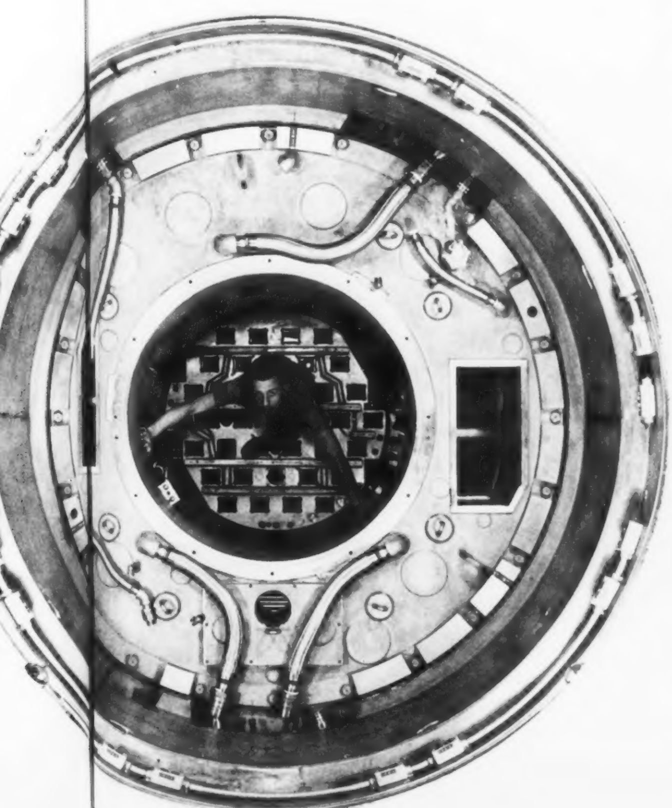
NBS technicians inspect one of the 13 beam ports of the Bureau's new 10-megawatt nuclear reactor, which has just been completed. The radioactivity will be confined by the 2-m-thick concrete wall to a small space at the height of the ports. The ports will be plugged, or open only to shielded experimental areas, so that no radiation hazards will be present. Fuel will be loaded and operation monitored and controlled from the level above.

Charles Hook, of the NBS staff, stands on the upper grid plate in the Bureau's reactor to show size of the fuel transfer area. This area will be completely sealed by a top plug, before the reactor is placed in operation, and the cavity around it also closed.

A particularly important use of the neutron beams from the reactor will be in the study and measurement of such nuclear processes as fission and neutron capture. Inadequate understanding of the fission process and lack of information on neutron yields still limit the design of breeder reactors. The high flux from the reactor will also be used to generate radioisotopes for a wide variety of purposes, such as activation analysis and tracer production, as well as for distribution as radioactivity standards.

In addition, studies of the effects of radiation on materials will be carried out with the reactor by in-pile irradiation of bulk matter. The information obtained in this way should be of great value, both for basic knowledge in solid state and chemical physics and for application to radiation processing and altering the properties of structural materials.

Basically, the reactor consists of an enriched uranium core, moderated and cooled by heavy water and contained in a large aluminum vessel. Thermal and biological shields surround the core vessel and attenuate the radiation (which reaches a level of 10^{14} neutrons/cm^2/sec.) to biological and instrument tolerance level. Thirteen beam tubes, or ports, running outward from the core region, permit the radiation to be used in studying materials. The reaction is controlled remotely from a control room.



Reactor Core

The reactor core consists of a hexagonal array of 24 plate-type fuel elements (of the MTR, or materials testing reactor, type), immersed in heavy water. The uranium fuel is enriched to 93 percent in the uranium 235 isotope, the remainder being uranium 238. To prevent contamination of the coolant, the fuel is alloyed with aluminum and then clad with aluminum to form a sandwich. Each fuel element consists of 17 parallel plates with gaps to allow heavy water coolant flow through it.

Reactor fuel elements differ from the usual element by being fueled both above and below an 18-cm aluminum "gap" between uranium sections. Nine experimental beam tubes terminate in the vicinity of the vertical gap, thereby allowing extraction of neutron beams which are considerably freer of fast neutrons and gamma rays than those that can be obtained from the usual configuration. Two other beam tubes go to a cryogenically cooled moderator which slows down neutrons from the core. Two more tubes go completely through the reactor along lines tangential to the core. Materials inserted in these two tubes can be brought in close proximity to the core.

Water flows through the core at a rate of 19 m^3/minute when the reactor is operating at 10 MW. In addition to serving as a coolant, the heavy water in the core slows down fast-moving neutrons, released when a uranium 235 nucleus fissions, to the thermal-neutron energy level, so that these neutrons can be captured and the reaction continued.

The heat generated by the fissioning uranium 235 is removed from the reactor core by heavy water circulated within a closed aluminum system. The heavy water first circulates through the reactor and then enters a heat exchanger, where it transfers its heat to ordinary water and returns to the core. The ordinary water transfers its heat to the atmosphere through evaporation from a cooling tower located outside the reactor building.

Reactor Control

Two mechanisms operated from the control room can control the rate of the core reaction. Four safety arms fabricated from cadmium with an aluminum cladding provide the primary control. They are lifted from the core when the reactor is to be started (in the presence of a neutron source). If an undesirable condition develops during regular operation, these arms automatically fall back into the core, stopping the reaction and shutting down the reactor. To provide fine control of reactor power during regular operations, a cylindrical rod of aluminum filled with helium is automatically raised or lowered between the fuel elements.

continued

HIGH-FLUX REACTOR *continued*

In addition to the control rod and the safety arms, helium may be bubbled into the core or the heavy water at the top of the reactor may be dumped if needed. In both cases, a chain reaction ceases because sufficient neutrons to sustain the reaction are not available. If necessary for emergency shutdown, the safety arms, the top heavy water dump, and the bubbler system can be brought into action collectively from the control room.

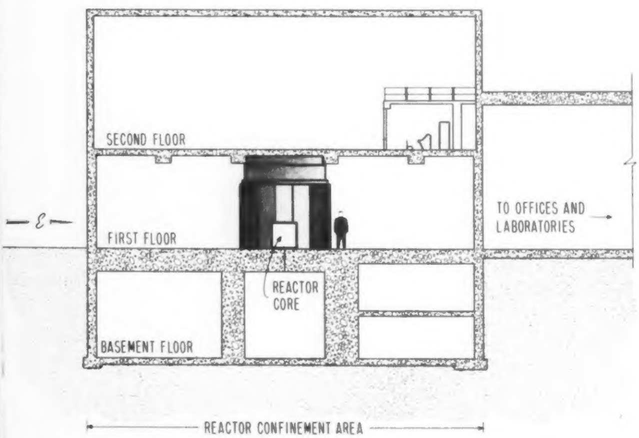
The Building

The reactor building has two main parts. The front or east portion houses laboratories, offices, shops, and other special-purpose areas. In the rear, a confinement building houses the reactor. In the basement of the confinement building is located special-purpose equipment for operation and control of the reactor. Specimens are inserted into beam ports on the first-floor level. The second floor provides access to the top of the reactor.

A special ventilation system filters the air and limits the spread of any airborne contamination appearing on any one floor. In the remote possibility that radioactive contamination should be released, it would be sensed by radiation detectors and emergency procedures would begin. Gasketed doors and shutoff valves would automatically close and seal the building.

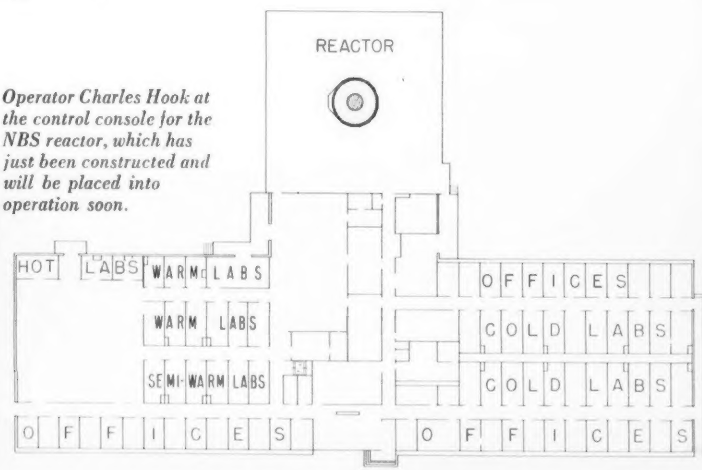
The confinement building is constructed of reinforced concrete and is sufficiently tight to assure low leakage. All leakage takes place from outside in, so that all air leaving the contaminated zone is filtered. Even under the worst hypothetical accident conditions, that is, if all the filtering should fail, the radiation dose to a person on the site boundary would be negligible.

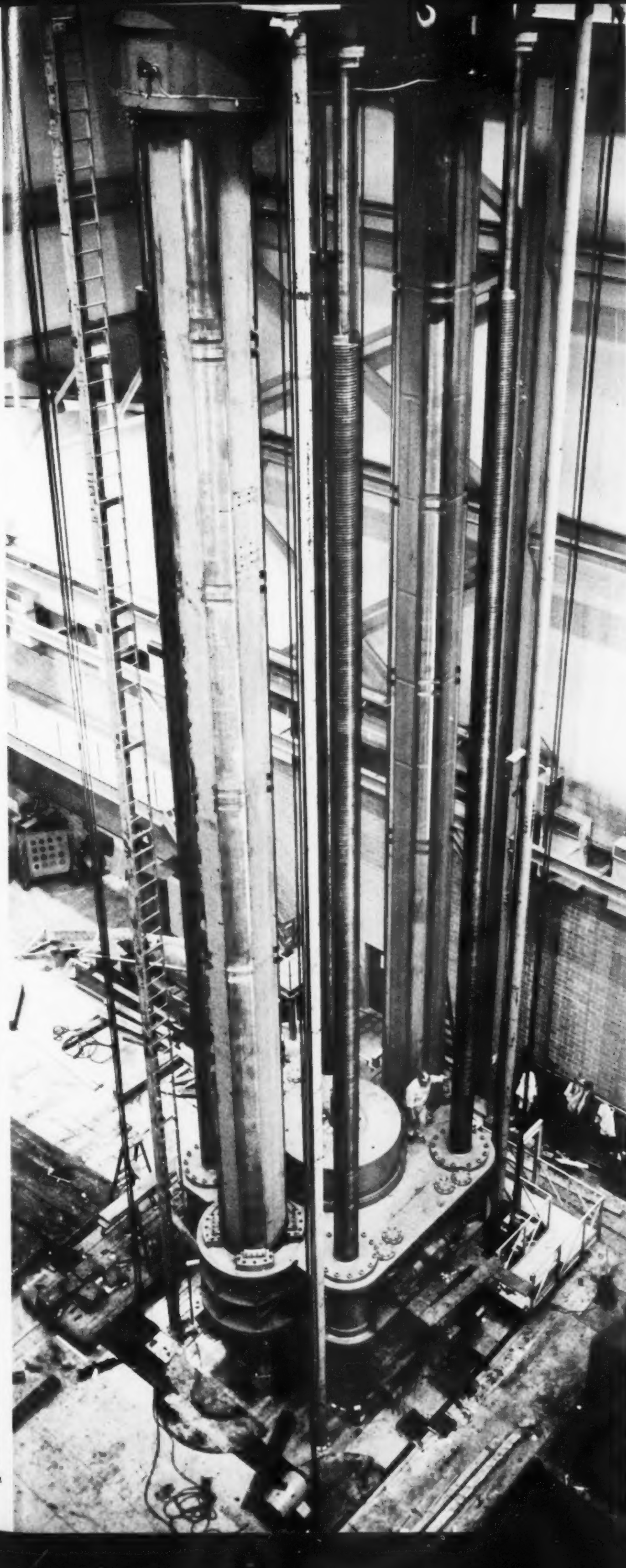
[1] Slow neutrons can enter nearly all atomic nuclei and produce nuclear rearrangements and fission in certain heavier ones, while slow charged particles cannot interact with nuclei at all because they are unable to penetrate the electrostatic energy barriers. The singular ability of neutrons to produce nuclear transmutations not only provides a unique and valuable method of probing nuclear structure but has made the practical realization of atomic energy a reality.



(Upper left) The new reactor is located in an especially reinforced and shielded area. Its operations are monitored and controlled at a console on the second floor. The radiation experiments are set up on the first floor, in front of one of the beam tubes running into the core; when a port is opened the material is irradiated in a beam of neutrons. Experiment shielding, building features, and redundant radiation monitoring devices insure that the ambient radiation will not rise to hazardous levels. The reactor confinement area can be completely sealed off in event of emergency. (Lower right) The reactor is housed in its own wing of the reactor building at the Bureau's new Gaithersburg, Md., complex. The laboratories are grouped, as shown by this floor plan, according to the precautions that must be taken for protection against radioactive hazards.

Operator Charles Hook at the control console for the NBS reactor, which has just been constructed and will be placed into operation soon.





DEDICATION
ISSUE / TNB

Twelve-million-lbf capacity hydraulic testing machine, believed to be the world's largest, is now being installed in the Engineering Mechanics Building. A unique facility, the machine will provide the force to calibrate multimillion-lbf capacity force-measuring devices for space and industrial applications and to test full-scale structural components. The machine has a total height of 101 feet, including 21 feet in a pit.

Special Building Required for

FORCE MEASUREMENT PROGRAM

ONE OF THE MORE striking features of the new Gaithersburg (Md.) campus is the Engineering Mechanics Building, a multilevel structure designed for the Bureau's facilities for force standardization and for research on structural elements. Housed within the building are a variety of compression and tension testing machines including a new 12-million-pound universal testing machines which, when completed, will be the largest testing machine in the country. The building also contains a 1-million-pound deadweight force-calibrating machine which is also the largest machine of its type. The Bureau has long recognized the need for these devices to give support to space, defense, and industrial programs, but it was not feasible to install them at the old site because of their great size.

continued

FORCE-MEASUREMENT PROGRAM *continued*

The standardization programs under way in the Engineering Mechanics Building include the development and maintenance of standards of force, the development of specialized standardards for vibration-measuring devices, and calibration services by which these standards control working standards for industry and government. Other allied activities include a laboratory for the comparison of mass standards ranging from 50 to 60,000 pounds and a motor vehicle scale laboratory designed for research in problems of weighing large highway transport trucks.

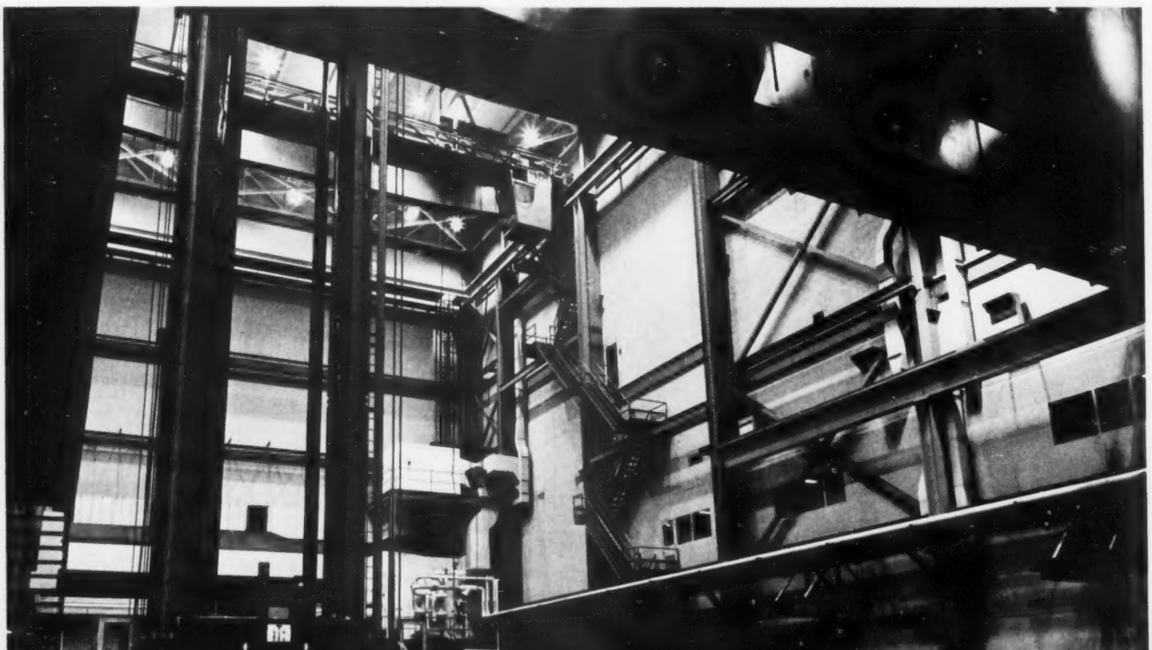
The building also encompasses activities devoted to research on the performance of structures and strain-measuring equipment at both room and elevated temperatures. The standardization and research programs contribute essential support to the design and construction of structures, the operation of high performance aircraft, and to the development of missiles and space vehicles.

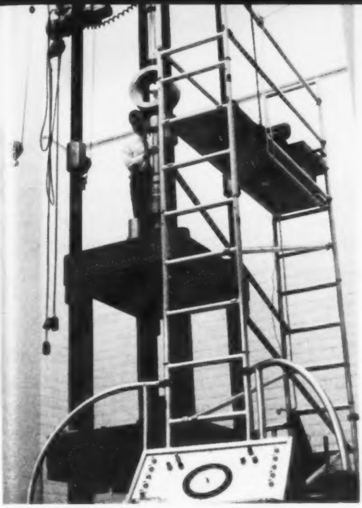
The complex and massive nature of the equipment to be installed required a building of special design and thus accounts for the unusual appearance of the Engineering Mechanics Building. The 12-million-pound capacity testing machine, for instance, rises 80 feet above the ground level from a reinforced concrete pit 21 feet below ground. The machine is capable of supporting horizontal beams up to 90 feet long for flexural tests. In addition to its primary purpose for research and testing of structural elements, the machine has been designed to apply the precisely controlled loads needed for the calibration of load cells having capacities greater than 1 million pounds, which are used for such measurements as the determination of rocket thrust. In this mode of operation a big load cell is loaded in the machine against a group of smaller cells each of which has been calibrated previously by accurately known standards. This method of calibration does not require accurate indication of load by the testing machine but it does require that the load be maintained at a steady level while the load cell indicators are being balanced.

Another testing machine of interest is a horizontal machine capable of loads up to 2,300,000 pounds in compression and 1,150,000 pounds in tension. This machine, built in 1912, is still very useful and was moved from Washington to this building.

The building with its modern equipment has enabled the Bureau to extend and improve its capabilities in these areas to keep abreast of present-day requirements. The new force standards provide accuracies 10 to 15 times greater than previously available. Also, the time required for calibra-

The large test area in the Engineering Mechanics Building was designed to house the Nation's largest universal testing machine (left). This machine is capable of applying loads up to 12,000,000 lbf.





A. J. Mallinger of the National Bureau of Standards completes the installation of a 400,000-lb-capacity proving ring for calibration in the 1,000,000-lbf capacity deadweight testing machine.

tions above 100,000 pounds has been considerably reduced.

The Engineering Mechanics Building is divided into several distinct areas. There is a large test area, a three-level deadweight machine area, a vibration calibration area, a scale house, several small laboratories, a machine shop, and office space.

Large Test Area

The 12-million-pound-capacity machine is in the large test area, occupying a floor space of 75 by 169 feet. It is a high bay area with two ceiling levels: 97 feet—the highest point in the building—over the western portion where the large machine is located, and 54 feet over the eastern portion, where a variety of smaller equipment is placed. A 600,000-pound capacity tension and compression testing machine was moved from the old site into the large test bay. This machine is 40 feet high.

The south wall of the 54-foot-high area is provided with a balcony, 16 feet above the floor level. The balcony serves as the observation and control center for elevated-temperature tests of structures on the floor. Equipment located in this area includes a 60,000-pound precision platform scale; 10,000-pound and 50,000-pound capacity programmed load fatigue machines; and special equipment for studying the properties of materials subjected to rapid loading.

Materials for testing are conveyed through a metal rollup door 20 feet wide and 14 feet high, located on the west side of the building. Two bridge cranes to move equipment and tests samples serve the large test area.

Deadweight Machines

Deadweight machines are complex vertical devices that consist of a stack of weights at the bottom; a loading frame which is an accurately adjusted weight; a lifting frame to which the loading frame is linked by the device to be calibrated; and at the top, a hydraulic jack. As the hydraulic jack raises the lifting frame and (through the device being calibrated) the loading frame, the weights in the stack, which are connected together somewhat like links in a chain, are lifted one at a time from the top down. The number of weights picked up depends on the height to which the loading frame is raised.

A force-measuring device is calibrated by measuring (electrically or mechanically) the deformation of the device when the deadweight load is applied and comparing this measurement with one taken under a zero load condition. With these machines it is now possible to carry out calibrations in which the uncertainty of the applied load is less than 0.002 percent.

Previously, the largest deadweight machine at the NBS Washington grounds had a capacity of only 111,000 lbf. This machine was installed in 1927 when few force applying systems required accurately measured loads above 100,000 pounds. In the meantime and particularly since World War II, the number and capacities of precision force-measuring devices have greatly increased. Today, some have capacities as great as 12-million lbf. Continuing developments in rocket engines and space vehicles are expected to necessitate even greater capacities.

Before the new deadweight machines were installed in the Gaithersburg laboratory, industrial and Defense Department requirements had far outstripped the capabilities of the Bureau's equipment both for accuracy and capacity. To calibrate devices for measuring forces that were greater than the capacity of the deadweight machines, several interim processes had to be introduced. With each, however, an additional amount of error was also introduced.

While located in Washington, for example, the Bureau was asked by NASA to calibrate a load cell capable of measuring up to 1.5 million lbf that was used in the propulsion system for the man-in-space project. To calibrate the load cell, NBS had to improvise with existing equipment. This resulted in a lower level of accuracy than was desirable.

Six new deadweight machines, including three with capacities of 112,000, 300,000, and 1 million lbf, have been installed or are being completed in the new facility in addition to the 111,000-lbf capacity machine

continued

D. R. Bryant of the National Bureau of Standards' vibration laboratory calibrates an accelerometer system using an electrodynamic exciter (center background). The accelerometer is the small cylindrical device mounted at the top of the exciter. The voltage from the accelerometer system is compared to the voltage of a reference accelerometer system by the voltage ratio circuit (left). Waveforms are viewed on the oscilloscope at right.

A portion of the general test area in the Engineering Mechanics Building. Load-extension studies on the and notch toughness of materials. The machine at machine at right are used to determine fracture behavior left applies up to 200,000 lbf for determining the compressive properties of materials.

that was already in use. The other three machines have capacities of 500 lbf, 3050 kgf, and 25,300 lbf.

The four larger deadweight machines along the north wall of the large test area presented a difficult building design task. Each machine required three separate floor levels. At weightroom level, on the first floor of the building, the deadweight areas connect with the large test area. The second floor is the working area for calibrations. The hydraulic jack and power supply are located directly above the force calibration room.

Four of the weightrooms are equipped with pairs of steel I-section monorails, with capacities ranging from 3 to 12 tons and lifts of 14 to 25 feet according to the machine. These are to move the machine weights to the large test area where they can be checked for accuracy with the special 60,000-pound capacity scale.

Force-measuring devices arriving for calibration are transported from the building's shipping and receiving area into a preconditioning room for preparation. When the devices are ready, they are carried by elevator to the second floor level, transported along a 10-foot-wide corridor that separates the five force measuring rooms from the large test area, and delivered to the appropriate force measurement room.

Despite the variations in their heights, the deadweight machine rooms vary little in the dimensions of their floor areas, which are all about 30 by 30 feet except the rooms for the 1-million-lbf capacity machine which is about 30 by 40 feet. The 30-foot dimension is also the modular spacing of columns along the length of the large test area.

To minimize changes in the masses of the stainless steel weights due to corrosion, the weight rooms are air conditioned so as to assure that the relative humidity does not exceed 50 percent. During a calibration, temperatures in the measurement rooms can be held constant within 0.3 °C at any preselected nominal temperature between 10 and 38 °C.

Other Work Areas

Although the building was designed primarily to accommodate the large machines, it houses many other areas of work. A variety of these activities are carried out in the general mechanical test area. These include the development of equipment and techniques for obtaining stress-strain curves of refractory metals at temperatures up to 2,200 °C, a study of the appropriate measurement procedures for obtaining the material properties of full-size metal structural sections, development of equipment and methods for determining transient response characteristics of force-measuring devices, and tests of various materials to obtain data on their mechanical properties.

Another area of the building contains machines and instrumentation for studies of creep and stress-relaxation of metals subjected to elevated temperatures. Current work is directed toward the development of standard methods of testing, better measurement techniques, and the extension of the theory of inelastic deformation of solids.

One area is used to compare the relative performances of various clamps, wire holding devices, vibration dampers, and other hardware used by the electric power and telephone utilities receiving REA loans. Wire ties for connecting insulators to conductors are also investigated in this area.

The one-story wing on the northeast corner of the building contains a mass measurement laboratory and a scale house. Precision balances are used in the mass laboratory for determining the values of mass standards over the range of 50 to 1,000 pounds. The scale house contains a 100,000-pound capacity scale, 10 by

6[illegible] feet, for weighing complete tractor-trailer combinations and two 60,000-pound-capacity axle scales, 10 by 10 feet.

Another room contains research equipment that is being used to develop strain standards. Work is in progress to provide standards for calibration of strain gages at temperatures up to 1,370 °C with an accuracy of 0.5 percent.

Located in the building also is apparatus for studying specimens used to measure the fracture resistance of metals. A machine is adapted with an extensometer and a precise method of measurement that utilizes ac to dc voltage converters to determine deformations to a few parts per million. Load-extension measurements with this equipment yield valuable data important in studying fracture behavior and notch toughness.

Vibration Measurements

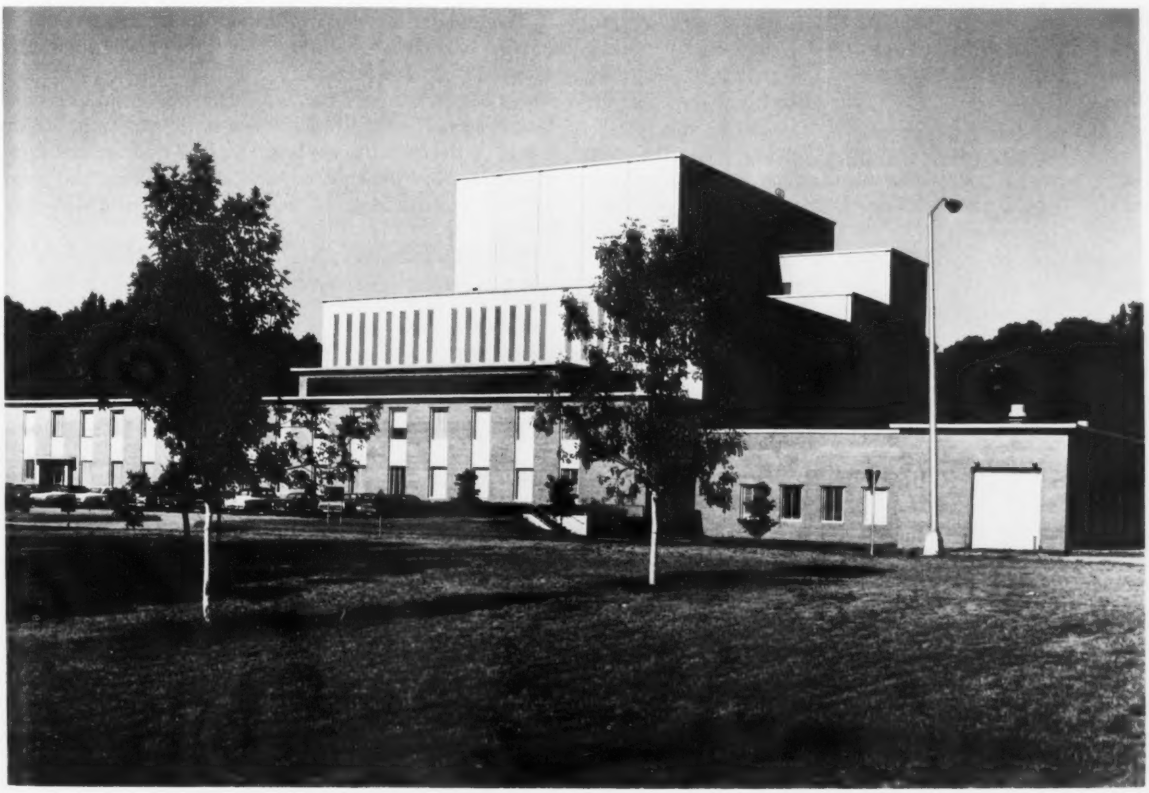
The building also houses a laboratory in which standards for the calibration of vibration measuring devices are developed. These are used to provide a calibration service for reference devices used in the calibration of vibration measuring devices in other laboratories. Vibration measuring devices are widely used in industrial and space applications to determine the performance of equipment components subjected to vibration. A laser-source measuring system is under study and is expected to measure displacements smaller than one microinch.

The vibration laboratory contains six isolated shaker blocks. Each is equipped with metal springs or air-suspension systems to eliminate external vibrations.

This room is also equipped with 3 vibration generators that produce vibrations from 10 hertz to 2,000 hertz for medium-range vibration calibrations. In calibrations between 1,500 and 20,000 hertz, vibration amplitude measurements are performed with an optical interferometer.

A teletype maintains communications between the calibration equipment and a time-sharing computer in Arlington, Va. Data from the equipment are taped and then sent by the teletype to the computer for evaluation. This process has reduced calibration time and saved many man-hours of computations.

The stepped rooftop design of the Engineering Mechanics Building was dictated by the functional requirements of large special purpose force-measuring machines.



DEDICATION
ISSUE / TNB

Unique Building Houses RADIATION PHYSICS Program

RECENT IMPROVEMENTS in methods for producing and detecting high-energy electrons have greatly increased the application of electron beams and x radiation in nuclear physics research, in medicine, and in industry. The radiation physics program of the NBS Institute for Basic Standards is designed to meet the Nation's needs in electron-beam, x-ray, and neutron technology by developing radiation standards and measurement methods and by obtaining basic data on the interaction of radiation with matter.

To house the large, complex, high-energy accelerators and x-ray machines required for this program, a unique structure was necessary that would provide the maximum of radiation safety combined with the minimum of radiation interference between research programs. A further requirement was that the building include laboratory and office space for all 77 professional members of the radiation physics staff so that they could perform different types of research while communicating easily with one another.

The Radiation Physics Building in the Bureau's new laboratory complex was constructed to meet these requirements. This building, first occupied in October, 1965, has been built on a four-wing design with about 71,000 square feet of assignable space. More than 65 percent of the structure is underground to provide inexpensive natural shielding by the earth.

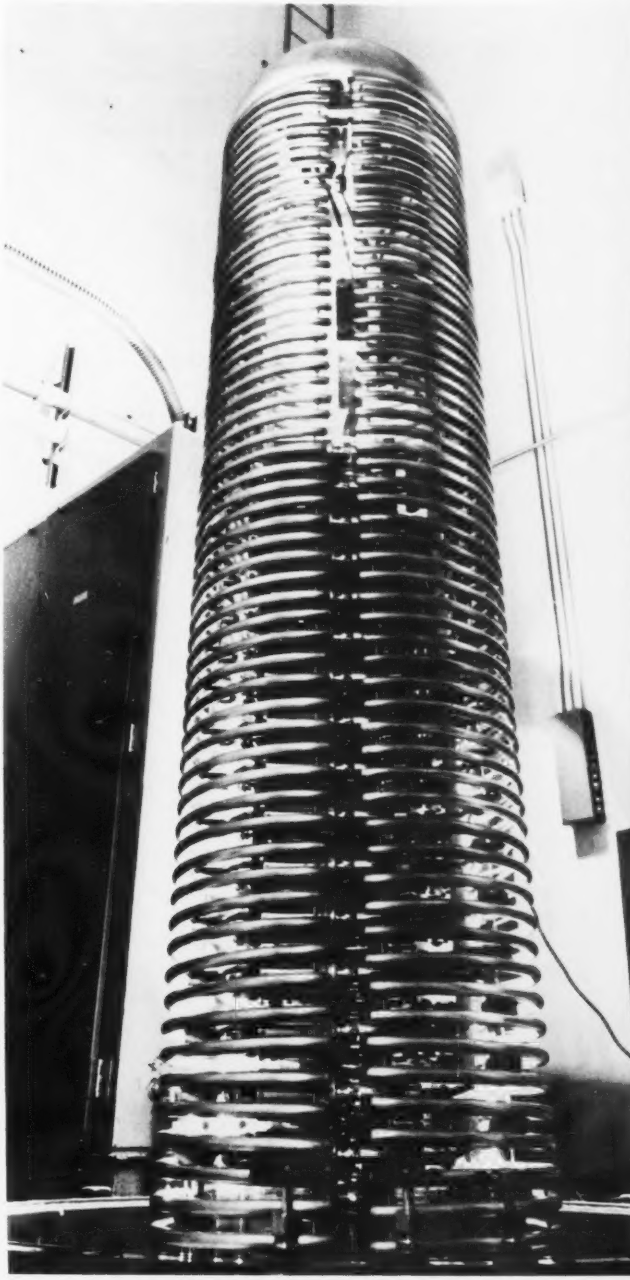
Above ground, the north wing consists of the main structure with three floors of general laboratory space and offices, where investigations involving low-level or no radiation are conducted. To avoid radiation interference with research activities in this wing, it is removed as far as possible from high-radiation areas in the building.

The remaining wings of the new facility house the high-energy particle accelerators and x-ray machines of the radiation physics division. The Bureau's powerful new linear accelerator, or linac, is located entirely underground in a wing projecting from the rest of the building. In the center of the building are two Van de Graaff accelerators, a new 1.5-MeV dynamitron, and other electron and x-ray producing machines, as well as space for a 180-MeV synchrotron.

Radiation protection has been carefully built into the new facility. High-intensity radiation sources in various

The Radiation Physics Building is divided into separate wings. At top is the three-story wing of offices and general laboratory space. Leading from that wing (towards center) is the wing housing the Van de Graaff and other high-energy accelerators. The first projection to the left is the low-scattering neutron measurement room. Projecting to the right is a low-level structure containing general laboratories. The next projection to the left is the wing that will contain the Bureau's 180-MeV synchrotron. The last wing (lower center) and the area underground below the stack houses the 100-MeV linac. The linac structure above ground contains the linac power and cooling rooms with the linac chamber on the subbasement level directly below. The stack exhausts air from the area of the linac measurement rooms.

The Bureau's new 1.5-MeV dynamitron is shown mounted vertically on the floor of the basement of the Radiation Physics Building. The 23-foot-high electron accelerator is powered by a radiofrequency transformer in the cabinet behind the accelerator, and the power is transmitted to the accelerator through the floor.



areas within the building are shielded by very thick concrete walls. Elaborate interlock mechanisms are also provided to prevent accidental entrance into areas of high level radiation, and some of the stairs and passages between different areas of radiation are built in a labyrinth to provide additional protection.

Linac Area

To reach the linac area from the main entrance of the building, a visitor walks about 400 feet along an underground corridor. The first room he reaches is the control room for the 100-foot-long accelerator. In this room electronic controls are provided to vary the electron beam energy from 10 to 100 MeV at power outputs greater than 40 kW—a power output about 100,000 times that previously available at NBS in the same energy range.

The high-intensity radiation output provided by the linac will enable NBS to enter new areas of nuclear and atomic physics. The results of this work will aid the Bureau in establishing new standards, measuring techniques, and shielding requirements for industrial uses of radiation in such applications as the sterilization of pharmaceuticals, preservation of foods, and polymerization of plastics. The 10 billion rad/hr dose from the linac will make it possible to set standards of dosimetry for radiation uses in this range.

The linac consists of nine 10-foot-long accelerator sections through which electrons are accelerated on the crest of a traveling electromagnetic wave. At the end of the linac is a magnet room where the electron beam is deflected into either of three measurement rooms.

The measurement rooms are adjacent but 12-foot-thick concrete walls provide shielding between them so that concurrent occupancy may be permitted. Entrance to these rooms is through interlocking concrete horizontal-plug shielding doors, each weighing 50 tons. Measurement rooms that are not receiving the electron beam may be entered during operation of the linac as access to each of the measurement rooms is independent of the magnet room.

The entire linac area is underground. It occupies two basement levels 32 feet below the street level of the building. On the subbasement level are the linac chamber, the magnet room, and the measurement rooms. The linac cooling room, the power room, and the control room are on the basement level. Access to the rest of the building is through corridors at both the basement and subbasement levels.

The linac wing is cooled by two different systems. The

continued

The NBS traveling-wave linear acceler tor t can generate 100-MeV electrons is shown. he ni 10-foot sections of the linac can be se

linac chamber and the measurement rooms are air-conditioned by a low-velocity, single-zone reheat system using 100 percent outside air. The power room and cooling room have a low-velocity multizone reheat system, which is designed to absorb the greater part of the heat released by the power generating equipment.

Other Particle Accelerators

The connecting wing between the north wing and the linac is a two-story structure that holds all of the Bureau's other accelerators except the synchrotron. One of the Van de Graaff accelerators is a new 4-MeV electron accelerator that can produce a continuous or pulsed electron beam with energies in the range of 0.8 to 4 MeV. This machine is mounted vertically at the basement level with two measurement rooms directly below the machine in the subbasement. A magnet directs the electron beam into either of the two rooms. The 4-MeV accelerator will provide the radiation physics programs with a facility that will fill a gap between the energy ranges available from the other NBS machines.

The second Van de Graaff machine is a 2-MeV positive ion accelerator primarily used to produce neutrons. This source of neutrons is used to measure neutron cross sections, to study nuclear structure with neutrons, and to calibrate neutron spectrometers and other neutron-measuring instruments. The accelerator is placed vertically on the first floor of the laboratory, and the positive ion beam is directed downward to a magnet room directly below the accelerator on the basement level. From the magnet room the beam can be sent to either of two experiment rooms, including a 40- by 40-foot room which has a grating floor and aluminum-paneled walls. This room provides low-scattering conditions for neutron experiments; background neutrons pass through the walls without being scattered back to interfere with experiments in the measurement area. This room projects from the west side of the wing and a fence is placed 25 feet from the building projection to provide radiation protection to persons outside the building.

Across the corridor from the 4-MeV Van de Graaff machine is the new 1.5-MeV electron dynamitron, which can provide electron beams at high currents with energies ranging from 0.25 to 1.5 MeV. This vertical accelerator is mounted above a well-shielded measurement room in the subbasement. The control room for the dynamitron is located adjacent to the measurement room.

Next to the dynamitron measurement room is a 0.5-MeV constant potential accelerator, which produces a stable, very-low-to-very-high-current electron beam. It is used for a variety of electron and electron-produced radiation experiments in the low-energy region. The measurement area is in the same room as the accelerator.

These four accelerators provide numerous radiation beams of varied energy and intensity. Such beams can be used to study the physics of the interaction of radiation with matter and the variety of secondary radiations thus produced. Studies of this kind are of value to the nuclear physicist investigating neutron production by electrons; to the radiation chemist who is interested in reaction rates; to the atomic physicist working with atomic spectra; and to those who produce or make use of radiation to process foods and materials.

Radiation protection is provided by 3- to 4-foot concrete walls in all of these rooms except the low-scattering neutron measurement room. People are kept out of these areas while the accelerators are in operation by steel doors, which are 8 to 12 inches thick to shield personnel.

Synchrotron

The Bureau's 180-MeV synchrotron has not yet been moved from the old NBS site in Washington. When the synchrotron is brought to the new Gaithersburg facility, this circular electron accelerator will be placed in a large, well-shielded room on the basement level in a separate wing between the Van de Graaff accelerators and the linac. A measurement room and control room will be located adjacent to the machine. The machine room will have large, 3-foot-thick movable slabs to provide shielding around the accelerator.

Other Radiation Areas

Most of the additional space in the subbasement of the low-energy accelerator wing is used for research and services applicable to radiological requirements. This work consists mainly of research, standardization, and calibration with application to equipment that measures x and gamma rays used for industrial and medical purposes. X-ray standards and calibrations are available over a range of 50 to 250 kV. Gamma-ray calibration ranges, using cesium 137 and cobalt 60, provide for dose rates from a few milliroentgens per hour to several thousand roentgens per hour.

These rooms are shielded by standard-size concrete blocks. The energies of the x and gamma radiations are not great enough to require additional shielding. Standard radiation safeguards are in effect, however, such as warning lights when the radiations are being used.

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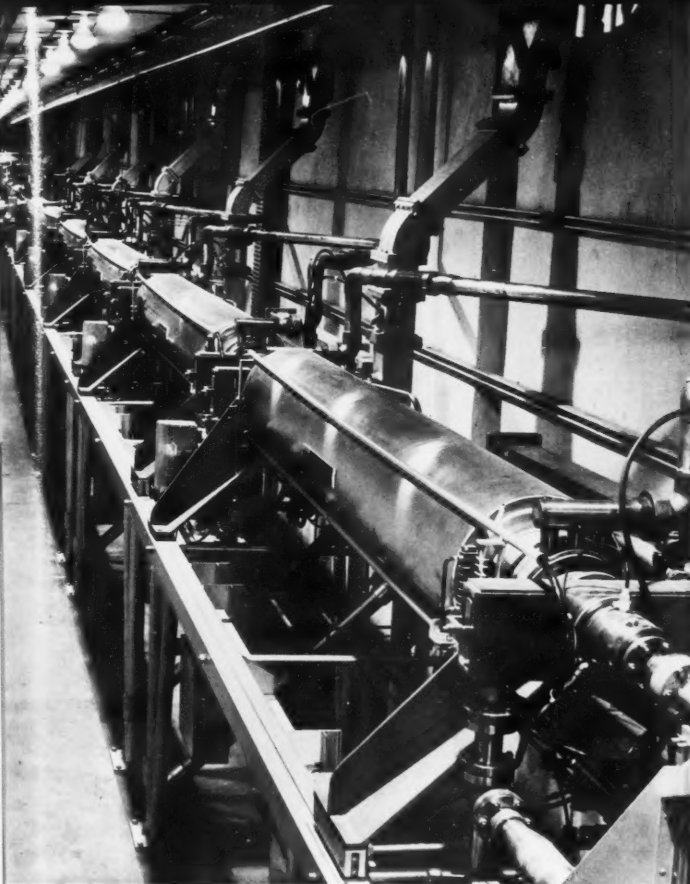
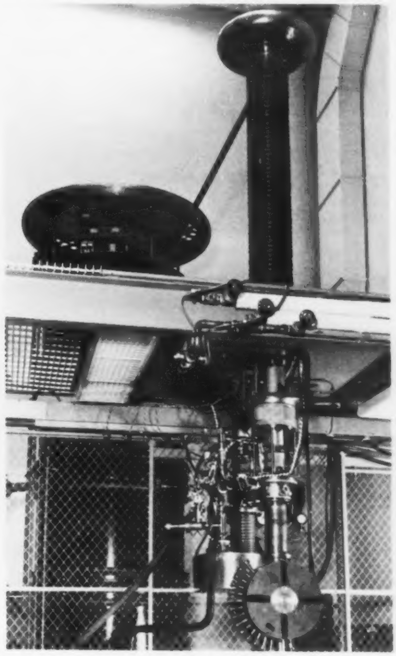
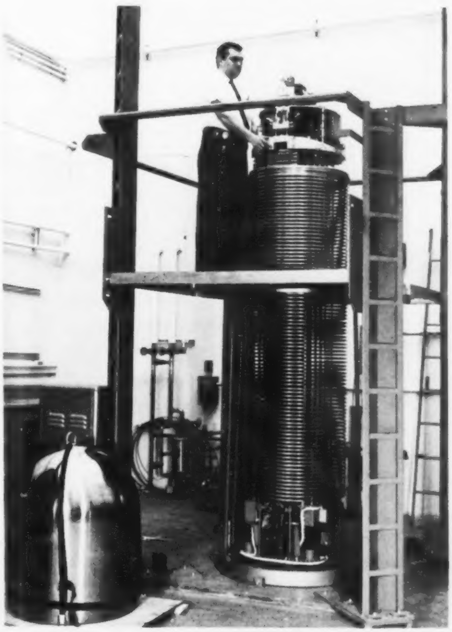


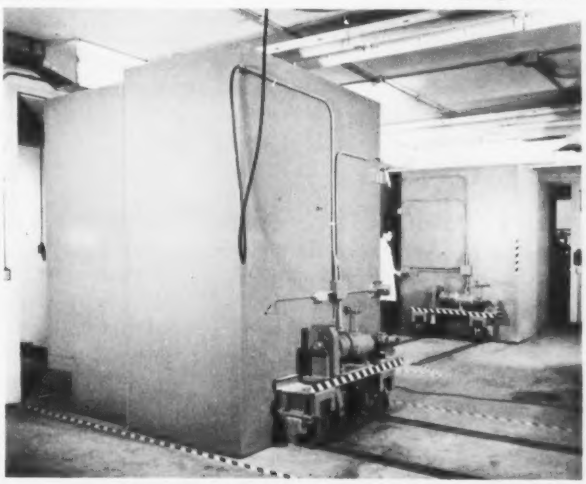
The 500-KeV constant potential electron accelerator is shown. The constant voltage is supplied from the transformer (upper left center) through the tube to the accelerator. The electron beam impinges on targets in the disk-shaped target area (bottom center) where a number of exit ports are provided.





Dr. Charles Dick checks 4-MeV Van de Graaff electron accelerator. The electron beam from this machine shoots downward to either of two measurement rooms in the basement below.

Radiation protection from the measurement rooms of the 100-MeV linac is provided by these 12-foot-thick-concrete horizontal-plug doors, each weighing 50 tons.



DEDICATION
ISSUE / TNB

Construction Under Way:

FOUR SPECIAL PURPOSE L

WITH 15 MAJOR buildings now completed on the NBS Gaithersburg site, work on the laboratory complex has been moving rapidly into "Phase 4" of the construction plans (see table, page 204). Four special-purpose research laboratories are now under construction as part of Phase 4: Concreting Materials (206), Industrial (231), Sound (233), and Hazards (236).[1] In addition, a fifth special-purpose building, the Fluid Mechanics Laboratory, and a Gatehouse are planned for the near future.

Though originally conceived as the final phase in the construction of and transfer to the new facilities at Gaithersburg, Phase 4 will not complete the story. Some loose ends will remain, and just how these are handled will depend on a number of factors, the most important being the changing requirements of the NBS program.

The *Industrial Building* will be a large structure devoted to industrial technology. It will provide specialized laboratories and furnaces for work on glasses, ceramics, crystals, and metals. Approximately half the building will comprise laboratories and specialized equipment related to textile and paper technology, including several paper mills of various sizes and purposes.

The *Sound Laboratory*, dedicated entirely to acoustical research, will have special laboratory facilities enabling it to perform an extensive and diverse array of sound measurements. Heading the list of features are new and larger anechoic and reverberation chambers. The anechoic chamber is a so-called "dead room" in which sound waves striking the floor, ceiling, or walls are almost totally absorbed by the deep acoustical wedges that line those surfaces. The reverberation chamber, to the contrary, is a "live room" whose inner surfaces are designed to reflect as much of the sound striking them as possible. For isolation, each of the chambers is being built as a shell within a shell, the inner shell "floating" on vibration isolators.

Other facilities in the Sound Laboratory will be used for calibrating microphones and vibration transducers, and for the measurement of small seismic disturbances.

To reduce the interference from sound and vibration of outside sources, the building has been placed relatively far from other laboratory and service buildings and from roadway and parking areas. Also, it has a minimum of exterior openings in the walls, and all of the walls, interior and exterior, are to be of heavier than normal masonry construction. On top of that, the mechanical and electrical equipment rooms will be structurally isolated from the rest of the building.

The *Hazards Laboratory* is so named because it will shelter activities in which there is a relatively high probability of dangerous accidents. Work will be done here, for example, on high pressure, long chain polymers, and the distillation of volatiles. Different laboratories within the building will be protected from one another by reinforced concrete walls and the rooms will be entered through protective concrete barricades. An outside wall of each laboratory is designed so that it will collapse easily and quickly in case of an explosion. The collapsible wall faces a 40-foot-high earth mound. The area will also be fenced, for further protection of those outside the building.

The *Concreting Materials Building* will provide equipment for batching, blending, and storing of aggregates to be used in structural concrete programs, in standard samples of aggregates and sands, and in standard soil samples for the interstate highway programs. The building is designed for trucks to drive up and dump their loads through openings in the roof.

The *Fluid Mechanics Laboratory* is still under study. Efforts are being made to determine just what types of research are anticipated in this technical area, so that the building can be tailored to fit them. Hopefully, it is planned to build such a facility in the near future.

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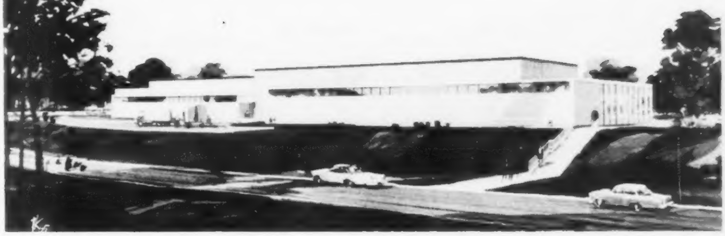
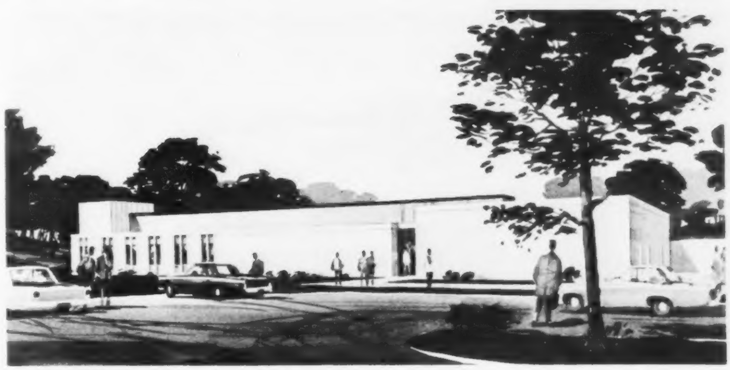
Artist's renderings show four special purpose labs developing at NBS, Gaithersburg (top to bottom), the Industrial Building, the Concreting Material Building, the Hazards Laboratory, and the Sound Laboratory





Also planned for the near future is a small *Gatehouse* for the admittance of employees and visitors outside regular working hours. Construction has been held up until the location can be decided upon. The original plan had been to build it at the north central entrance to the Bureau grounds. However, consideration is now being given to a new highway interchange on Interstate 70S close to the Bureau grounds. Until this is decided, construction on the Gatehouse will be deferred.

Among the "loose ends" mentioned above, are the *Fire Resistance Laboratories,* which are better known as the "burn laboratories." These laboratories will remain at the Washington site for the present. The fire research section, on the other hand, is being moved to the Gaithersburg site.

Phase 4 also does not provide for the relocation of the *High Voltage Laboratory*. It was decided that the facility at Washington will be adequate for the program for several years to come, and that it would be wasteful to build a new structure at the Gaithersburg site unless and until the program requirements change and make a new and different facility necessary.

[1] Numbers in parentheses are the building numbers which serve as alternative designations with the building names.

PUBLICATIONS

*of the National Bureau of Standards**

NBS HISTORY PUBLISHED

PUBLISHED late last summer, *Measures for Progress: A History of the National Bureau of Standards,*[1] marks the move of the Bureau from its old facilities in Washington, D.C. to new quarters in Gaithersburg, Md.

With an experienced historian, Rexmond C. Cochrane, as its author, and a foreword by Vannevar Bush, *Measures for Progress* tells the story of the Bureau's first 50 years, 1901 to 1951. The book was prepared under the editorial aegis of the late science editor and writer, James R. Newman.

This history will appeal to a number of types of readers. Those, for instance, who are interested in the story of this country's burgeoning commerce, industry, and science during that stimulating half century will enjoy following this story in *Measures for Progress.* In showing the Bureau's important role in that era, the author deftly pictures the era, too.

Dr. Cochrane had a difficult assignment: to cover such a complexity of technological and scientific, as well as administrative, events in a one-volume work. Nevertheless, he accomplishes it with a style that is both authoritative and interesting, bringing in personalities and incidents from time to time to give his story color.

The work is meticulously researched and thoroughly documented, and will prove valuable to persons who collect reference volumes of this kind. Dr. Cochrane averages 140 footnotes per chapter, and he has also provided a tremendous fund of information in the 15 appendices, the bibliographic note, and the careful index.

[1] Measures for Progress: A History of the National Bureau of Standards, NBS Misc. Publ. 275, may be purchased for $5.25 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; from any U.S. Department of Commerce Field Office; or from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151.

PERIODICALS

Technical News Bulletin, Volume **50,** No. 10, October 1966. 15 cents.

Annual subscription: $1.50. 75 cents additional for foreign mailing. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $5; foreign, $6. Single copy, $1.

Section B. Mathematics and Mathematical Physics. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $2.75; foreign, $3.50. Single copy, 75 cents.

CURRENT ISSUES OF THE JOURNAL OF RESEARCH

J. Res. NBS **70C** (Engr. and Instr.), No. 4, (October–December 1966), 75 cents.

Some techniques for measuring small mutual inductances. D. N. Homan.

Deflection of centrally loaded thin circular elastic plates on equally spaced point supports. A. F. Kirstein, W. H. Pell, R. M. Woolley, and L. J. Davis.

Reproducibility of germanium resistance thermometers at 4.2° K. M. H. Edlow and H. H. Plumb.

Calibration of vibrating sample magnetometers. W. E. Case and R. D. Harrington.

Notes on the use of propagation of error formulas. H. H. Ku.

The apparent thermal radiation properties of an isothermal V-groove with specularly reflecting walls. R. B. Zipin.

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Cast iron soil pipe and fittings, CS188-66 (July 1, 1966), 40 cents. (Supersedes CS188-59).

TFE-Fluorocarbon (polytetrafluoroethylene) resin sintered thin coatings for dry film lubrication, CS274-66 (Jan. 20, 1966), 10 cents.

Analytical mass spectrometry section: instrumentation and procedures for isotopic analysis, Ed. W. R. Shields, Tech. Note 277 (July 25, 1966), 60 cents.

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Activation-analysis program and facilities at the National Bureau of Standards, J. R. DeVoe and G. W. Smith, Proc. 1965 Intern. Conf. Modern Trends in Activation Analysis, Texas A&M University, College Station, Tex., pp. 225–229 (April 1965).

Additional observations on the electronic spectrum of copper (II) acetate monohydrate, C. W. Reimann, G. F. Kokoszka, and G. Gordon, J. Inorg. Chem. 4, No. 7, 1082–1084 (July 1965).

Density and specific gravity, J. K. Taylor, Encyclopedia of Industrial Analysis 1, 546–560 (Interscience Publ. Inc., New York, N.Y., 1965).

Determination of trace amounts of tellurium in standard reference materials by neutron-activation analysis, D. A. Becker and G. W. Smith, Proc. 1965 Intern. Conf. Modern Trends in Activation Analysis, Texas A&M University, College Station, Tex., pp. 230–235 (April 1965).

Electron paramagnetic resonance and nuclear magnetic resonance as analytical tools, T. C. Farrar (Proc. Conf. Purification of Materials, New York Academy of Sciences), Ann. N.Y. Acad. Sci. **137,** 323–334 (January 1966).

Equilibrium pressures of oxygen over Ag_2O-Ag at various temperatures, E. M. Otto, J. Electrochem. Soc. **113,** No. 7, 643–645 (July 1966).

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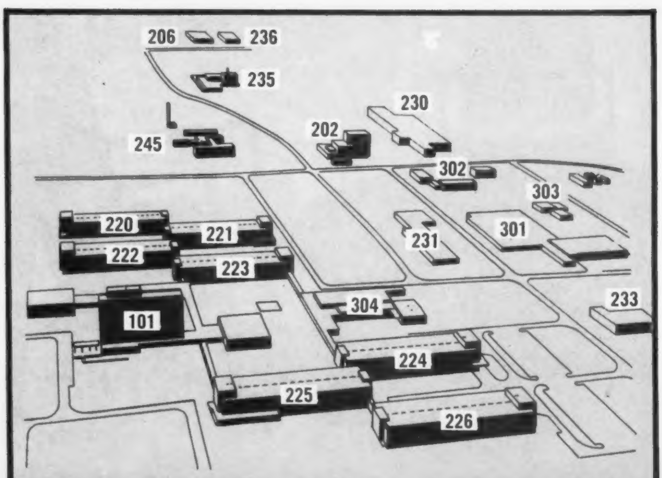

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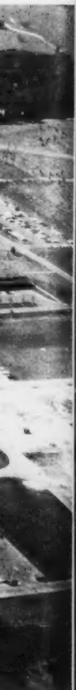

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